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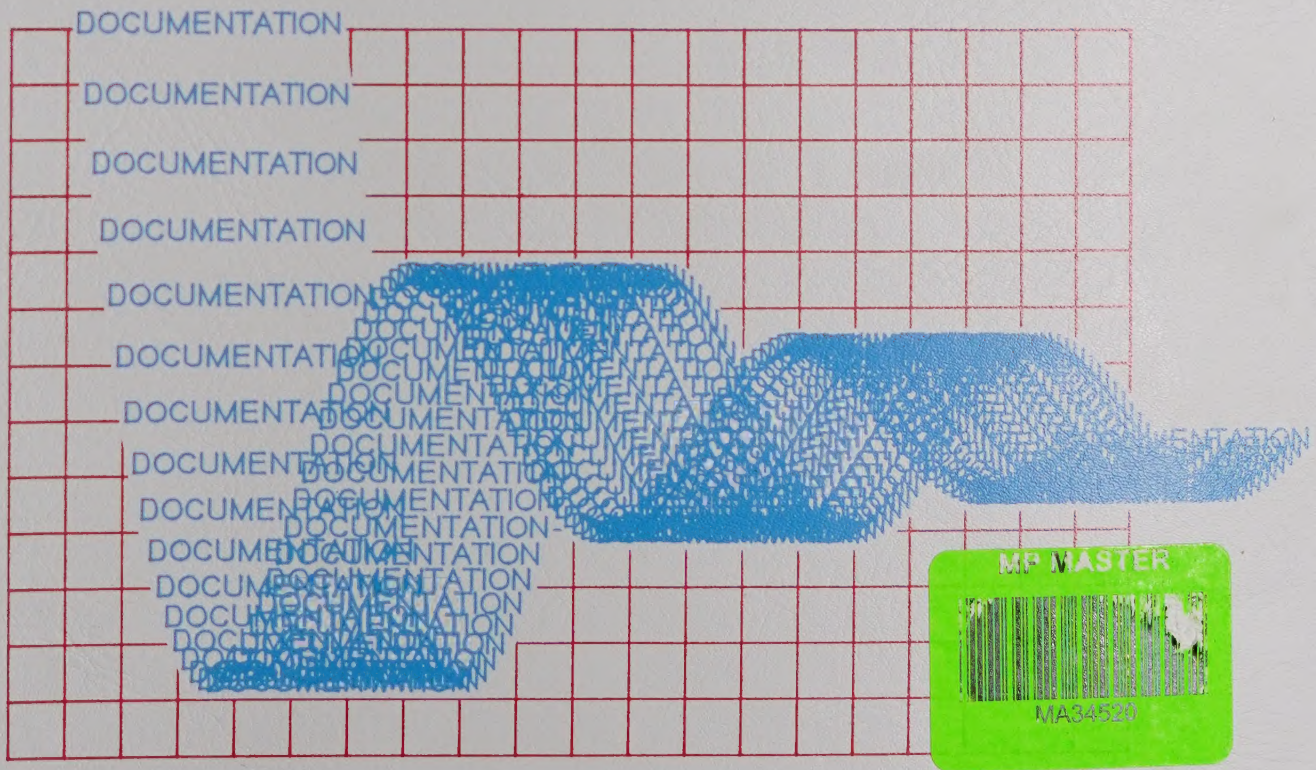
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ROHDE&SCHWARZ

Test and Measurement
Division

## Operating Manual

# RMS/PEAK VOLTMETER

# URE3

**350.5315.03**

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## Qualitätszertifikat

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde & Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Qualitätsmanagementsystems entwickelt, gefertigt und geprüft. Das Rohde & Schwarz-Qualitätsmanagementsystem ist u.a. nach ISO 9001 und ISO 14001 zertifiziert.

## Certificate of quality

Dear Customer,

You have decided to buy a Rohde & Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards. The Rohde & Schwarz quality management system is certified according to standards such as ISO 9001 and ISO 14001.

## Certificat de qualité

Cher client,

Vous avez choisi d'acheter un produit Rohde & Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité. Le système de gestion qualité de Rohde & Schwarz a été homologué, entre autres, conformément aux normes ISO 9001 et ISO 14001.

ROHDE&SCHWARZ

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## Appendix A


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# 2 Preparation for Use

The RMS/PEAK VOLTMETER URE3 is an rms-responding, peak-responding and dc voltmeter as well as a frequency counter, controlled by two microprocessors.
Using a

- patented rms-responding rectifier circuit,
- microprocessor-controlled autocalibration and
- computed frequency response correction depending on the frequency measured automatically

it enables unrivalled measuring characteristics.

The URE3 is designed such as to be excellently suited both for daily bench applications and for use in systems with automatic measurements.

## 2.1 Putting into Operation

### 2.1.1 Setting up

The URE3 may be operated in any position; when using a power cable with an angle connector (R&S stock number DS 086.4400), it may also be operated in the upright position.

- ***Do not obstruct the ventilation holes!***
- ***Ambient temperature 0 to 50 °C***
- ***Water must not be allowed to condense on the URE3. If this has occurred, the URE3 must be allowed to dry before switching on.***

### 2.1.2 Rackmounting

Using the Adapter ZZA-97 (order number 827.4527.00), the URE3 can be mounted in 19" racks according to the mounting instructions enclosed.

***When mounting the instrument in a rack, make sure that a total switch-off facility is directly accessible as the power switch is located at the rear of the instrument.***

### 2.1.3 Power Supply

The URE3 is designed for operation from AC supply voltages (sinewave) of 100 V, 120 V, 220 V and 240 V ± 10 % and frequencies between 47 and 440 Hz.

The instrument is factory-set to an AC supply voltage of 220 V; however, this voltage can be easily changed to another supply without opening the instrument. Proceed as follows:

- Disconnect the power cable
- Lift off the cover of the voltage selector at the rear using a screwdriver.
- Remove the coding cylinder that is now accessible and reinsert such that the desired voltage value points upwards.

- If necessary, lift off the fuse holder marked by an arrow, insert an appropriate fuse and reinsert the holder.
  Fuses for 100 V or 120 V: IEC127-T500H/250 V
  220 V or 240 V: IEC127-T250H/250 V
  See also the labelling at the rear of the instrument.
- Close the cover by pressing firmly. The voltage value selected can now be seen in a small window on the cover.

Connect the instrument to the power outlet using the power plug and the power cable supplied.

***Note the relevant provisions according to VDE/IEC.***

### 2.1.4 Switching On, Switch-on Status, Basic Setting

Switch on the URE3 by means of the power switch on the rear panel of the instrument. The display will subsequently read out the following messages:

| | |
|---|---|
| U R E 3 V x.y I E C z z | URE3: instrument designation<br>Vx.y: firmware version number<br>IECzz: IEC-bus address currently set |
| S E L F T E S T O.K. | No error has occurred in the internal self-test checking the function of the hardware. |

***The switch-on status of the instrument is always the status valid preceding the last switch-off.***
*Exception → 3.5.13*

The basic setting is selected by means of RCL0 → 3.2.3.12.

### 2.1.5 Explanation of Terms

A few terms repeatedly used in the following manual are to be explained below:

| Term | Explanation |
|---|---|
| Measurement task | The program part of the internal control program that provides a measurement result after triggering. |
| Query | IEC-bus command which, complemented by a "?", requests a response, e.g. IECOUT 20, "RESULT?" |
| Header | • First word in an IEC-bus command or<br>• additional information preceding a measured value displayed → 3.5.7.1.2 |
| Parser | Facility checking the semantics and syntax for the IEC-bus commands |
| Service Request | By setting the IEC-bus line SRQ, the instrument requests service from the controller and the application program in the controller branches into an interrupt routine. |
| Engineering exponent representation | Exponent representation in steps of three<br>E-18 E-15 E-12 E-09 E-06 E-03 E+00 E+03 E+06 E+09 E+12<br>(a) (f) (p) (n) (µ) (m) (-) (k) (M) (G) (T) |

## 2.2 Fitting the In/Out Option URE3-B2

- Unscrew the feet on the rear panel (loosen the 4 Phillips screws).
- Push the top and bottom cover towards the rear of the instrument and remove.
- Remove the covers of the connectors at the rear of the instrument.
- Screw the connector panel of the option to the rear panel of the instrument by means of two Phillips screws (proceed from the bottom of the instrument) and run the flat cable to the top of the instrument.
- Insert the plastic spacers supplied (4 pieces) into the holes on the computer board (top of the instrument).
- Engage the option board into the plastic spacers.
- Remove the connection cable of plug X60.
- Connect the flat cable sockets with the corresponding plugs.
- Complete the instrument. Ensure when mounting the bottom cover that the User's Guide booklet is not harmed!

### 2.2.1 Calibration of the DC Outputs

After fitting the In/Out Option URE3-B2, the DC outputs must be calibrated. The calibration is performed by the URE3 itself and not by an external device, which assumes that the URE3 has already been calibrated.

To perform the calibration the URE3 measures the DC output voltage of the DC output with two different voltages and calculates a correction value which is stored in a non-volatile memory.

***Calibration procedure → A1.10***

# 3 Operation

## 3.1 Explanation of Front and Rear-panel Views

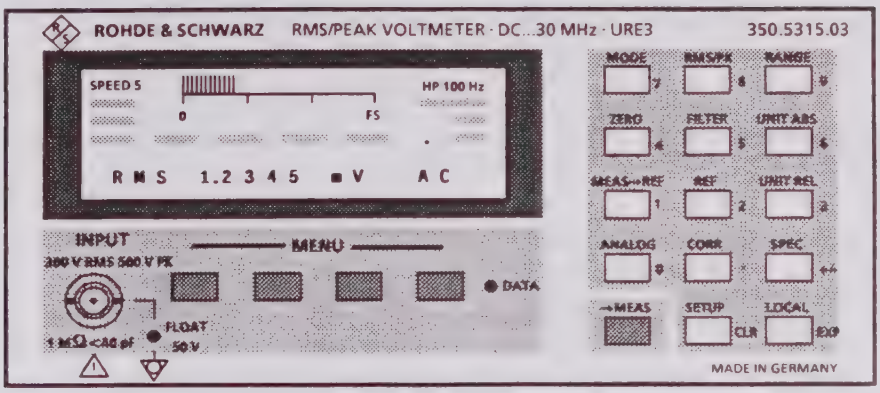
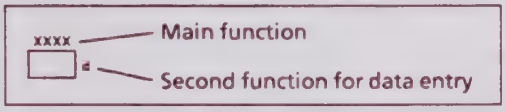



Fig. 3-1 Front view




MODE 7

Modes of measurement and operation → 3.2.3.1
- AC, DC, AC + DC,
- Level or frequency display, combined frequency/level display
- Reference potential of outer conductor of BNC input socket FLOAT or GND
- Frequency measurement FRONT or REAR (included in In/Out Option URE3-B2)

RMS/PK 8

Rectifier selection → 3.2.3.2
- Root-mean-square value RMS
- Peak value + PK, -PK, P-P

RANGE 9

Selection of measurement range → 3.2.3.3
Auto Range, Range Hold, Range Fix

ZERO 4

Offset voltage suppression → 3.2.3.4
Retaining and display of value, switch on/off

FILTER 5

Measurement speed, lower and upper cutoff frequency → 3.2.3.5
- Measuring time 30 ms to 60 s
- Lower cutoff frequency 0 Hz (DC coupling), 10 Hz, 100 Hz or 2000 Hz
- Upper cutoff frequency 20 kHz, 100 kHz, 1 MHz

UNIT ABS 6

Display units (without reference) → 3.2.3.6
V, dBu, dBV, dBm, W, dBµV

MEAS→REF 1

Retaining the measurement result as reference value → 3.2.3.7

REF 2

Entry of reference and impedance for relative and power measurements → 3.2.3.8

- Level reference value
- Frequency reference value
- Impedance value

UNIT REL 3

Relative display units → 3.2.3.9
ΔdB, %V, ΔV, V/Vr, P/Pr, %W, ΔW, F/Fr, %F, ΔHz

ANALOG 0

Analog display and analog outputs → 3.2.3.10

- Analog display for dynamic range of level
- Analog display with automatic scale
- Analog display with selectable scale

CORR .

Correction of measurement result → 3.2.3.11

- Frequency response correction
- Correction of level measurement result

SPEC +/-

Special functions → 3.2.3.13

- Set IEC-bus address
- Selection of extreme-value displays
- Enable external trigger
- Illumination of LCDs
- Display test
- Initialization of memory area with battery backup
- Calibrate DC outputs
- Suppress error message "DEVICE-Err. abcd"

→MEAS

Return to measuring function → 3.2.3.15

SETUP CLR

Complete instrument setups

- Store in a non-volatile memory and recall → 3.2.3.12
- Switch on/off MODE memory → 3.4.1

LOCAL EXP

Return to manual operation → 3.2.3.14

MENU

In conjunction with readings on the display, the 4 keys labelled MENU permit to select further settings.

The blue labelling shows the meaning for data entries. (→ 3.2.2)

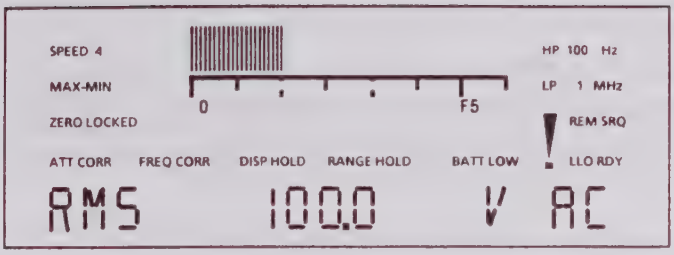



Fig. 3-2 Display

Meaning of the fixed messages on the display:

SPEED x: Measurement speed: → 3.4.2.1

| Measurement speed with RMS | Meaning | Measurement speed with PK | Meaning |
|---|---|---|---|
| 0 = INTV TIME | Measurement over a fixed period of time | 0 = INTV TIME<br>1 = INTV TIME | Measurement over a fixed period of observation |
| 1 = SYNC TIME | Measurement searching for periodicity | | |
| 2 = SYNC 10 | Measurement searching for periodicity of the test signal over 10 s | 2 = INTV 10 | Measurement over a fixed period of observation 10 s |
| 3 = SYNC 1 | Measurement searching for periodicity of the test signal over 1 s | 3 = INTV 1 | Measurement over a fixed period of observation 1 s |
| 4 = SLOW | approx. 1 measurement/s | 4 = SLOW | approx. 1 measurement/s |
| 5 = FAST | approx. 3 measurements/s | 5 = FAST | approx. 3 measurements/s |
| 6 = SUPERFAST | approx. 30 measurements/s | 6 = SUPERFAST | approx. 30 measurements/s |

LOCKED: A signal periodicity has been found for measurement speeds SYNC TIME, SYNC 10 or SYNC 1. → 3.4.2.1

ZERO: Offset voltage suppression is switched on. → 3.4.4

MIN: Indication of extreme value: The smallest level or frequency value measured is indicated on the display. → 3.4.10

MAX: Indication of extreme value: The greatest level or frequency value measured is indicated on the display. → 3.4.10

MAX-MIN: Indication of extreme value: The difference between the greatest and the smallest level or frequency value measured is indicated on the display. → 3.4.10

ATT CORR: Correction of level measurement result is switched on. → 3.4.7.1

FREQ CORR: Frequency response correction is switched on. → 3.4.7.2

FREQ CORR : Letters blinking: Frequency response correction is switched on, but no frequency count result can be determined by the instrument → 3.4.7.2

DISP HOLD: Measurement result is retained in order to be transferred to the reference memory. → 3.4.8

RANGE HOLD: Autoranging is switched off. → 3.4.3.2,→ 3.4.3.3

REM: Controller is connected to the instrument via IEC bus. → 3.5.4.2.1

| | |
|---|---|
| LLO: | Switchover to manual operation with LOCAL key not possible. → 3.5.4.1.2 |
| SRQ: | Instrument requests service from controller. → 3.5.9 |
| RDY: | Measurement result is available. → 3.4.12 |
| HP dd: | Lower cutoff frequency for level measurements. → 3.4.2.2 |
| LP dd: | Upper cutoff frequency for level measurements. → 3.4.2.3 |
| BATT LOW: | Battery voltage for the RAM with battery backup is too low. |
| ! : | Internal cyclical calibration is active. Measured value is not renewed as long as "!" is displayed. → 3.5.13 |

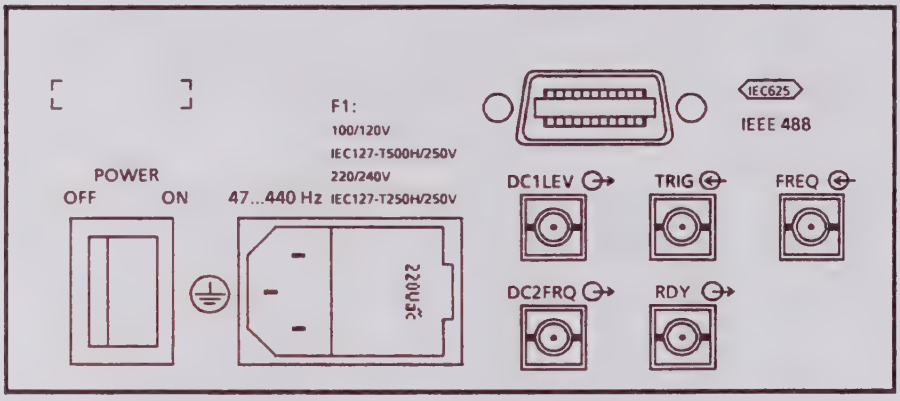
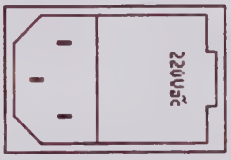



Fig. 3-3 Rear view

Switching on → 2.1.4




Power supply → 2.1.2

IEC-bus connection → 3.5.3.1

DC output for level display → 3.4.11

DC output for frequency display → 3.4.11

External trigger input → 3.4.12

Ready output for measurement result → 3.4.13

Rear frequency input → 3.4.1.6.2

## 3.2 Manual Operation

Due to its manifold functions, the URE3 has been equipped with menu-driven operation so as to combine a small number of keys arranged in a clear way with high ease of operation. The 15 keys in the right-hand keypad permit to select the superior functions, whereas the four keys labelled MENU in conjunction with the reading on the display allow to select further settings.

### 3.2.1 General Notes on Menu Operation

A menu can be entered via one of the keys in the right-hand keypad. The display of measured values is aborted, and the first menu line of the selected function is read out. The menu messages indicated on the display show further possible settings and are assigned to the menu keys.

Pressing of a menu key causes either a measurement to be performed immediately in the selected setting or a further menu level to be called up. The structure of the menu is such that the most important and most often used functions are to be found in the highest menu levels so that the desired setting can be obtained by just a few key strokes.

Meaning of general menu messages:

"more": More selections are possible than can be shown in the display line. Pressing of the menu key identified by "more" allows to scroll over the other possible settings in this menu level.

"menu": Same as "more", except that the user returns to the beginning of the menu level after pressing this key.

"ZERO*": A message followed by an asterix is meant to be understood as a comment. Pressing of the menu key below does not produce any response.

### 3.2.2 Data Entries During Menu Operation

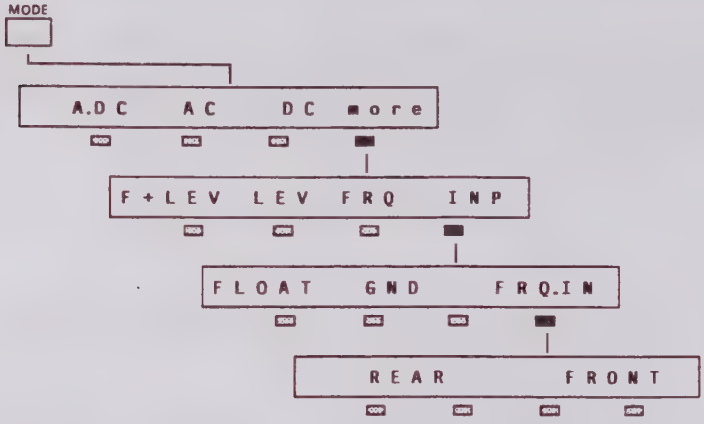
A number of settings require the entry of numerical values, which is indicated by lighting up of the LED labelled with DATA. As long as this LED is illuminated, the keys in the right-hand keypad are assigned a numerical meaning as indicated by the blue labelling.

| | |
|---|---|
| 0 ... 9 | Entry of numbers |
| . | Decimal point |
| +/- | Sign of the mantissa or exponent<br>(depending on how far the entry has already progressed) |
| EXP | Entry of an exponent |
| CLR | permits entered data to be corrected by deleting the wrong value |

### 3.2.3 Menu Trees and Brief Operating Instructions

For the sake of clarity, the following brief operating instructions for manual operation additionally include the corresponding IEC-bus commands.

### 3.2.3.1 Modes of Measurement and Operation




A.DC: AC + DC measurement → 3.4.1.2, 3.4.1.4
IEC-bus command: `"MODE:FUNCTION:ACDC"`

AC: AC measurement → 3.4.1.1, 3.4.1.3
IEC-bus command: `"MODE:FUNCTION:AC"`

DC: DC measurement → 3.4.1.5
IEC-bus command: `"MODE:FUNCTION:DC"`

F + LEV: Read out frequency and level value together on the display
IEC-bus command: `"MODE:DISP:FRQLEV"`

LEV: Read out only level value on the display
IEC-bus command: `"MODE:DISP:LEV"`

FRQ: Read out only frequency value on the display. Nevertheless, a level measurement is also performed with the mode of measurement set.
IEC-bus command: `"MODE:DISP:FRQ"`

INP: Branches to the next menu level for selection of the settings for the input sockets.

FLOAT: Outer conductor of BNC input socket is not connected to ground (earthed conductor).
FLOAT LED lights up.
IEC-bus command: `"MODE:INPUT:FLOAT"`

GND: Outer conductor of BNC input socket is connected to ground (earthed conductor).

***Only reference potential! No safety connection according to VDE 0411!***

FLOAT LED does not light up.
IEC-bus command: `"MODE:INPUT:GND"`

FRQ.IN: Branches to the next menu level for selection of the input socket for the frequency measurement.

FRONT: The frequency counter derives the frequency from the test signal applied at the BNC socket at the front of the instrument. → 3.4.1.6.1
IEC-bus command: `"MODE:FRQIN:FRONT"`

REAR: Frequency measurement via rear BNC input socket
(included in In/Out Option URE3-B2) → 3.4.1
IEC-bus command: `"MODE:FRQIN:REAR"`

### 3.2.3.2 Selection of Rectifier: Rms Value (RMS), Peak Value (PK)

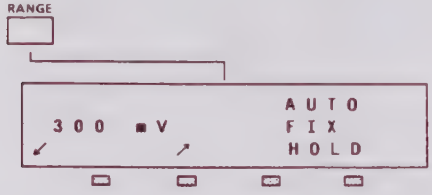
RMS: Rms-responding rectifier → 3.4.1.1, 3.4.1.2
IEC-bus command: `"DETECTOR:RMS"`

+PK: Peak-responding rectifier (positive peak value) → 3.4.1.3, 3.4.1.4
IEC-bus command: `"DETECTOR:PEAK_POS"`

-PK: Peak-responding rectifier (negative peak value) → 3.4.1.3, 3.4.1.4
IEC-bus command: `"DETECTOR:PEAK_NEG"`

P-P: Peak-responding rectifier (peak-to-peak value) → 3.4.1.3, 3.4.1.4
IEC-bus command: `"DETECTOR:PEAK_PEAK"`

### 3.2.3.3 Selection of Measurement Range




↙: Select lower measurement ranges (more sensitive)

↗: Select higher measurement ranges (less sensitive)

AUTO: Autoranging → 3.4.3.1
IEC-bus command: `"RANGE:AUTO"` (Autoranging ***without*** preselection of range)
`"RANGE:AUTO 1MV ... 1000V"` (Autoranging ***with*** preselection of range)

HOLD: Hold the set measurement range as the lowest range; when the range is exceeded, change to higher voltage ranges. → 3.4.3.2
IEC-bus command: `"RANGE:HOLD"`
`"RANGE:HOLD 1MV ... 1000V"`

FIX: Maintain the set measurement range at any rate. → 3.4.3.3
IEC-bus command: `"RANGE:FIX"`
`"RANGE:FIX 1MV ... 1000V"`

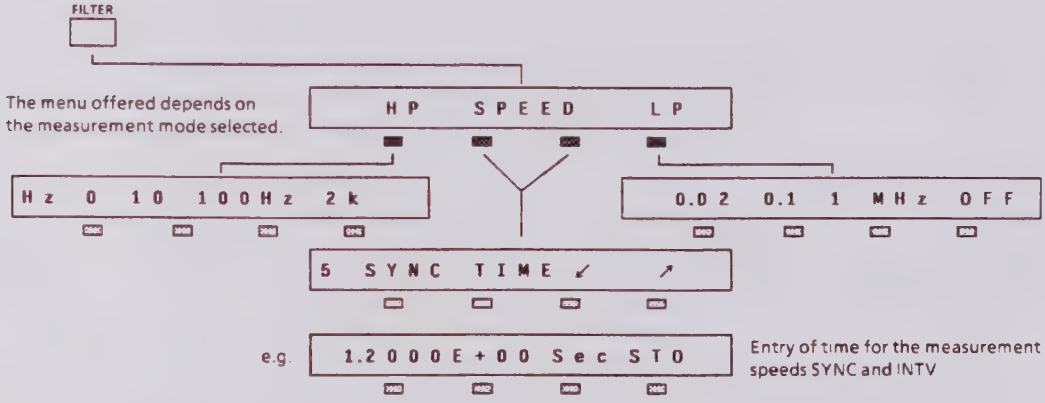
### 3.2.3.4 Offset Voltage Suppression

RCL: Display zero compensation value → 3.4.4.2

EXEC: Measure and store offset voltage and switch in offset voltage suppression → 3.4.4.1
IEC-bus command: `"CORRECTION:ZERO:EXECUTE"`

ON/OFF: Switch on or off offset voltage suppression → 3.4.4.3
IEC-bus commands: `"CORRECTION:ZERO:ON"`
`"CORRECTION:ZERO:OFF"`

### 3.2.3.5 Measurement Speed, Lower and Upper Cutoff Frequency


FILTER
The menu offered depends on the measurement mode selected.
HP SPEED LP
Hz 0 10 100Hz 2k
0.02 0.1 1 MHz OFF
5 SYNC TIME ↙ ↗
e.g.
1.2000E+00 Sec STO
Entry of time for the measurement speeds SYNC and INTV

HP: Selection of lower cutoff frequency (highpass filter) → 3.4.2.2
Lower cutoff frequency for HP: less than 1% reduction in amplitude

1 kHz: Lower cutoff frequency 1000 Hz
IEC-bus command: `"FILTER:HP 1000Hz"`

100 Hz: Lower cutoff frequency 100 Hz
IEC-bus command: `"FILTER:HP 100Hz"`

10 Hz: Lower cutoff frequency 10 Hz
IEC-bus command: `"FILTER:HP 10Hz"`

OFF: Processing of measured value with DC coupling.
IEC-bus command: `"FILTER:HP 0Hz"`

SPEED: Selection of measurement speed → 3.4.2.1

↙: Lower measurement speed

↗: Higher measurement speed
IEC-bus command: "FILTER:SPEED :INTV dd.dddE±ds"
:SYNC dd.dddE±ds"
:SYNC10 or INTV10
:SYNC1 or INTV1
:SLOW
:FAST
:SUPERFAST

TIME: Entry of the time interval between measurements for the measurement speeds SYNC (1) and INTV (0)
IEC-bus command: "FILTER:SPEED:SYNC dd.dddE±ds"
"FILTER:SPEED:INTV dd.dddE±dms"

LP: Selection of upper cutoff frequency (lowpass filter) → 3.4.2.3
Upper cutoff frequency for LP: -3 dB reduction in amplitude

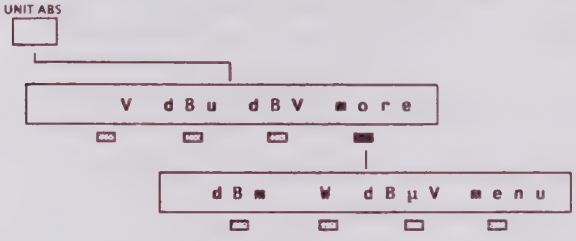
0.02: Upper cutoff frequency 0.02 MHz (20 kHz)
IEC-bus command: "FILTER:LP 20kHz"

0.1: Upper cutoff frequency 0.1 MHz (100 kHz)
IEC-bus command: "FILTER:LP 100kHz"

1 MHz: Upper cutoff frequency 1 MHz
IEC-bus command: "FILTER:LP 1MHz"

OFF: Switch off lowpass filter
IEC-bus command: "FILTER:LP:OFF"

### 3.2.3.6 Absolute Display Units (Without Reference)




V: IEC-bus command: "UNIT:LEV:V"

dBu: IEC-bus command: "UNIT:LEV:dBu"

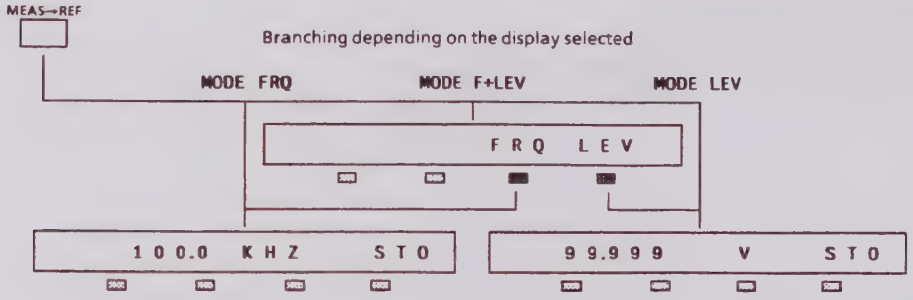
dBV: IEC-bus command: "UNIT:LEV:dBV"

dBm: IEC-bus command: "UNIT:LEV:dBm"

W: IEC-bus command: "UNIT:LEV:W"

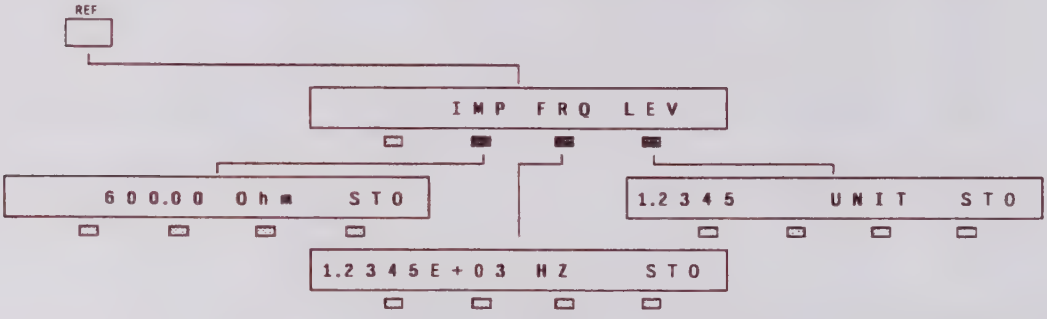
dBµV: IEC-bus command: "UNIT:LEV:dBuV"
→ 3.4.6.1

### 3.2.3.7 Using the Measured Value as Reference Value for Relative Measurements




STO: Stores the current measurement result as a reference value. → 3.4.8
IEC-bus command: "XTRREF?"

### 3.2.3.8 Entry of Reference and Impedance for Relative and Power Measurements




IMP: Permits to enter the impedance in Ω for the display unit in dBm or W → 3.4.5.3

FRQ: Permits to enter a frequency reference value in Hz for the display units F/Fr, %F, ΔHz → 3.4.5.2

LEV: Permits to enter a level reference value for the display units ΔdB, %V, ΔV, V/Vr, P/Pr, %W, ΔW → 3.4.5.1

UNIT: Selection of the unit of a level reference value by repeated pressing of the menu key

STO: Stores the impedance, frequency or level value entered

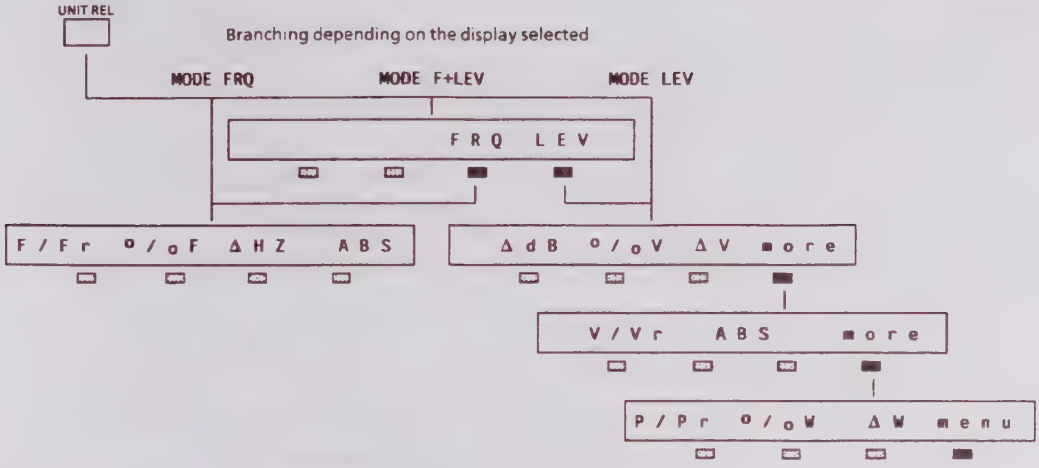
IEC-bus commands: Entry of impedance: `"REFERENCE:IMP dd.dddE±d"`

IEC-bus commands: Entry of frequency reference value: `"REFERENCE:FRQ ±dd.dddE±d"`

IEC-bus commands: Entry of level reference value:

```
"REFERENCE:LEV :V ±dd.dddE±dV"
               :W ±dd.dddE±dW
               :dBV ±dd.dddE±dBV
               :dBu ±dd.dddE±dBU
               :dBµV ±dd.dddE±dBUV
               :dBm ±dd.dddE±dBM
```

### 3.2.3.9 Relative Display Units


UNIT REL
Branching depending on the display selected
MODE FRQ
MODE F+LEV
MODE LEV
F R Q L E V
F / Fr %/oF ΔHZ ABS
ΔdB %/oV ΔV more
V / Vr ABS more
P / Pr %/oW ΔW menu

dB: IEC-bus command: `"UNIT:LEV:DdB"`

%V: IEC-bus command: `"UNIT:LEV:DPCV"`

ΔV: IEC-bus command: `"UNIT:LEV:DV"`

V/Vr: IEC-bus command: `"UNIT:LEV:V_Vr"`

ABS: Switch to the absolute level unit last selected (V, dBV, etc.)
IEC-bus command: `"UNIT:LEV:V", "UNIT:LEV:dBV" ...`

P/Pr: IEC-bus command: `"UNIT:LEV:P_Pr"`

%W: IEC-bus command: `"UNIT:LEV:DPCW"`

ΔW: IEC-bus command: `"UNIT:LEV:DW"`
→ 3.4.6.2

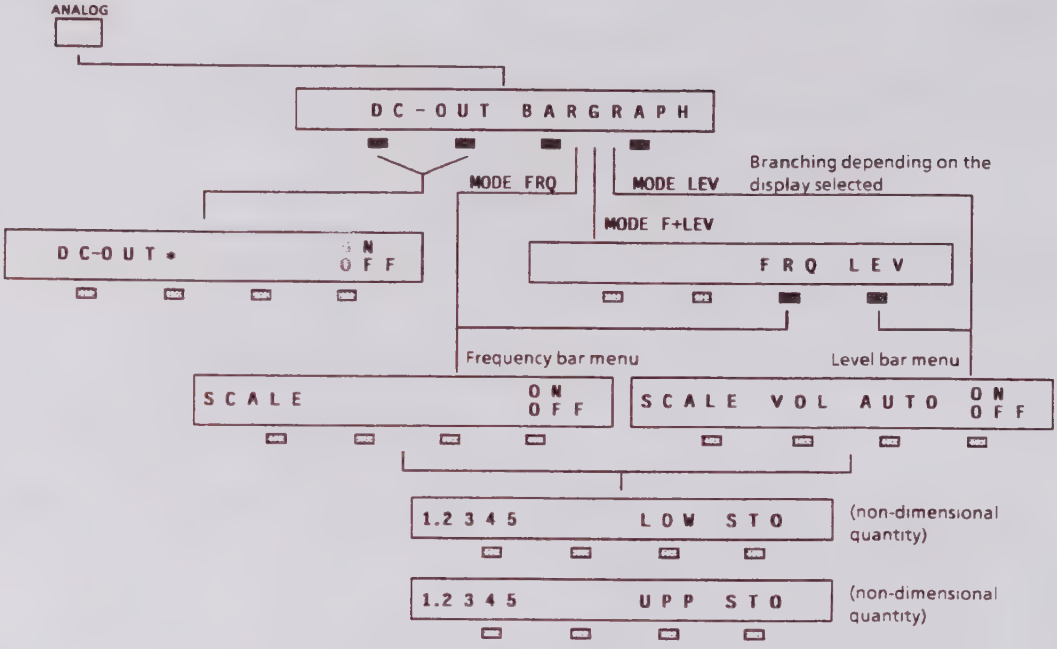
F/Fr: IEC-bus command: `"UNIT:FRQ:F_FR"`

%F: IEC-bus command: `"UNIT:FRQ:DPCHz"`

ΔHZ: IEC-bus command: `"UNIT:FRQ:DHz"`
→ 3.4.6.4

ABS: Switch to the frequency unit Hz
IEC-bus command: `"UNIT:FRQ:Hz"`
→ 3.4.6.3

### 3.2.3.10 Analog Display and Analog Outputs




DC-OUT: Selection of DC outputs

ON/OFF: Switch on or off DC outputs → 3.4.11
IEC-bus commands: `"ANALOG:DCOUT:ON"`
`"ANALOG:DCOUT:OFF"`

BARGRAPH: Selection of analog display

VOL: Analog display for level volume
IEC-bus command: `"ANALOG:BARGRAPH:LEV:VOLUME"`

AUTO: Scale of analog display adapts to any measurement result
IEC-bus command: `"ANALOG:BARGRAPH:LEV:AUTO"`
`"ANALOG:BARGRAPH:FRQ:AUTO"`

SCALE: Enter the menu of the freely selectable full-scale values

LOW: Enter the lower full-scale value

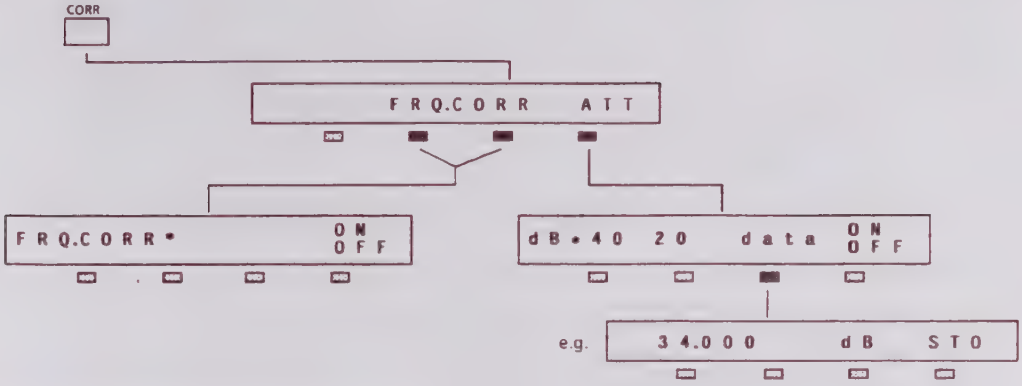
UPP: Enter the upper full-scale value

STO: Store lower or upper value
IEC-bus commands: `"ANALOG:BARGRAPH:LEV:SCALE_LOWER ±dd.dddE±d"`
`"ANALOG:BARGRAPH:LEV:SCALE_UPPER ±dd.dddE±d"`
`"ANALOG:BARGRAPH:FRQ:SCALE_LOWER ±dd.dddE±d"`
`"ANALOG:BARGRAPH:FRQ:SCALE_UPPER ±dd.dddE±d"`

ON/OFF: Switch on or off analog display
IEC-bus commands: `"ANALOG:BARGRAPH:LEV:ON"`
`"ANALOG:BARGRAPH:FRQ:OFF"`

→ 3.4.9.1, 3.4.9.2, 3.4.9.3, 3.4.9.4

### 3.2.3.11 Correction of Measurement Result




FRQ.CORR: Selection of frequency response correction

ON/OFF: Switch on or off frequency response correction → 3.4.7.2
IEC-bus command: `"CORRECTION:FRQRESPONSE:ON"`
`"CORRECTION:FRQRESPONSE:OFF"`

ATT: Correction of level measurement result

40: Correction of measurement result 40 dB when using a probe 100/1

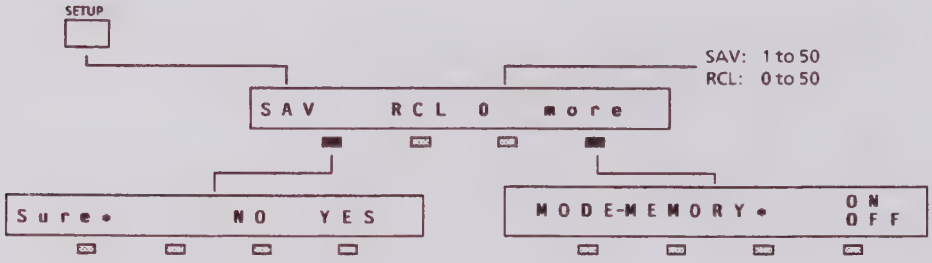
20: Correction of measurement result 20 dB when using a probe 10/1

ON/OFF: Switch on or off correction of measurement result
IEC-bus command: `"CORRECTION:ATTENUATION:ON"`
`"CORRECTION:ATTENUATION:OFF"`

data: Entry of any measurement result correction factor in dB
- Positive dB values for preceding attenuator pad
- Negative dB values for preceding amplifier

STO: Store measurement result correction factor and switch in correction of measurement result. → 3.4.7.1
IEC-bus command: `"CORRECTION:ATTENUATION ±dd.dddDB"`

### 3.2.3.12 Storing Complete Instrument Setups in a Non-volatile Memory and Recalling




SAV: Store complete setup in a non-volatile memory at location 1 to 50.
The purpose of the additional inquiry "Sure* NO YES" is to prevent the complete memory setup from being overwritten inadvertently.
IEC-bus command: `"*SAV 5"` (Example) → 3.5.5.2.4

RCL: Recall complete setup from location 0 to 50.
IEC-bus command: `"*RCL 5"` (Example) → 3.5.5.2.4

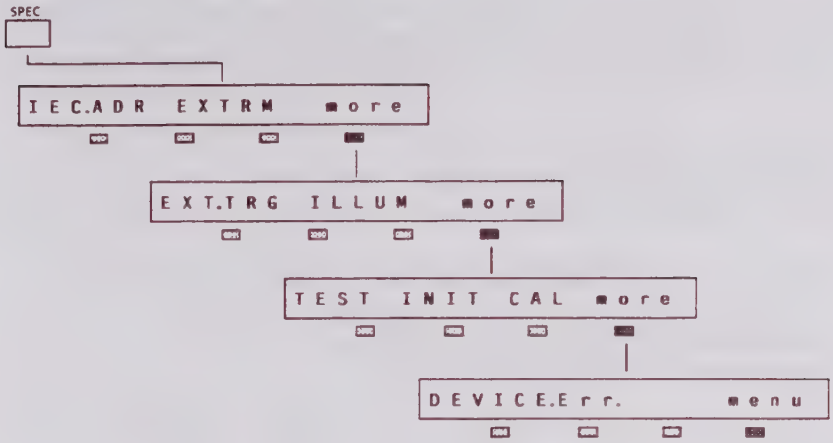
***RCL 0 always calls up the basic setting → 3.5.5.2.2***
***IEC-bus command: "*RCL 0"***

more: Switch to next menu level.

MODE-MEMORY* ON: With each MODE (AC, DC, ACDC) and DETECTOR (RMS, peak) change, the current setup is stored in a non-volatile memory and the complete instrument setup of a corresponding previous setting is recalled. → 3.4.1
IEC-bus command: `"MODE:MEMORY:ON"`

MODE-MEMORY* OFF: The instrument setup is maintained without being altered after changing the MODE or DETECTOR. → 3.4.1
IEC-bus command: `"MODE:MEMORY:OFF"`

### 3.2.3.13 Special Functions

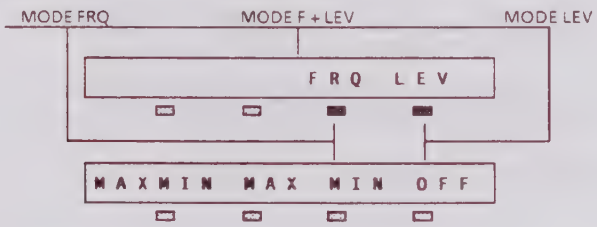



IEC.ADR →

STO:Store new IEC-bus address 0 to 30
→ 3.5 3

EXTREM →

Branching depending on the display selected




Selection of extreme-value display for level and/or frequency measurement result depending on the display selected →3.4.10.

MAXMIN: Reset maximum value - minimum value and start
MAX: Reset maximum value and start
MIN: Reset minimum value and start
OFF: Switch off display of extreme value

IEC-bus commands:

| | |
|---|---|
| "MODE:EXTREME:LEV:MAXMIN" | "MODE:EXTREME:FRQ:MAXMIN" |
| "MODE:EXTREME:LEV:MAX" | "MODE:EXTREME:FRQ:MAX" |
| "MODE:EXTREME:LEV:MIN" | "MODE:EXTREME:FRQ:MIN" |
| "MODE:EXTREME:LEV:OFF" | "MODE:EXTREME:FRQ:OFF" |

EXT.TRG →

Enable/disable external trigger input → 3.4.12
IEC-bus command: "TRIGGER:EXTERN:ON"
"TRIGGER:EXTERN:OFF"

ILLUM →

The illumination of the LCD can be varied in 7 steps:
↙: darker
↗: brighter
Resume measurement by pressing the →MEAS key.
IEC-bus command: "DISPLAY:ILLUMINATION d"

TEST →

Display test.
All display elements of the liquid crystal display are checked.
Resume the measurement by pressing the →MEAS key.
IEC-bus command: "DISPLAY:TEST"

KEY: Key test

prompts the user to press keys

On each subsequent key actuation, the front panel labelling of the respective key appears in the display to verify the proper functioning of all keys.
Resume the measurement by pressing the →MEAS key twice.

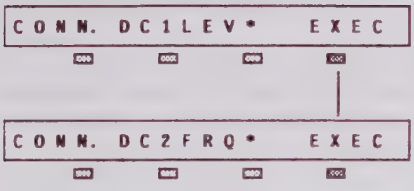
INIT →

The memory area of the instrument with battery backup is completely reinitialized. The memory areas for all complete instrument setups (→ 3.2.3.12) are deleted and loaded with the basic setting (→ 3.5.5.2.2).

***The calibration data of the instrument are preserved!***

The additional prompt "Sure* NO YES" is provided to ensure that not all complete instrument settings are unintentionally overwritten:
YES: Final and irrevocable deletion
NO: no deletion but measurement mode is resumed

CAL → Calibration of DC outputs




Connect output DC1LEV with the test input at the front and confirm the setting by pressing the menu key EXEC.

Connect output DC2FRQ with the test input at the front and confirm the connection by pressing the menu key EXEC.

IEC-bus commands:

```
IECOUT 20,"CALIBRATION:ON"
IECOUT 20,"CALIBRATION:DC_OUTPUT_LEV" or
IECOUT 20,"CALIBRATION:DC_OUTPUT_FRQ"
IECOUT 20,"CALIBRATION:EXECUTE"
```

DEVICE.Err →

ON: If an instrument error occurs, the error message "DEVICE-Err. 0800" (→ 3.2.4) is not suppressed.

OFF: If an instrument error occurs, the error message "DEVICE-Err. 0800" (hardware error in the analog section, error bit HE → 3.5.10.4 Device Errors) can be suppressed and the instrument resumes the measurement in spite of the error detected.

The error message is only suppressed for an error message where the special function DEVICE-Error* OFF has been output.

If an error message with a different code occurs subsequently, it is displayed again and the measured value is no longer displayed.

IEC-bus command: `IECOUT 20,"DISPLAY:DEVICE_ERROR:ON/OFF"`

### 3.2.3.14 Return to Manual Operation

**With IEC-Bus operation:**

Pressing of the LOCAL key allows to return from IEC-bus operation to manual operation unless the function of the LOCAL key has been locked by the IEC-bus command LLO (→ 3.5.4.1.2). Locking of the LOCAL key is indicated by the message LLO on the display.

When the instrument is in calibration mode, pressing of the LOCAL key causes a return to the measurement mode.

**With manual operation:**

Actuation of the LOCAL key effects brief display of the currently set IEC-bus address and switch-on of the internal cyclical calibration → 3.5.13.

### 3.2.3.15 Return to Measuring Function

By pressing this key, the menu entry can be terminated or aborted at any place in the menu in order to resume the measurement.

## 3.2.4 Error Messages

An incorrect entry made during menu operation causes an error message to be read out on the display for approx. 3 seconds. Then the menu line that has caused the error message is displayed again.

The following error messages may occur:

| Error message | Cause, remedy |
|---|---|
| Err. DC-MEAS | RMS/PK key pressed with DC measurement switched in. Selection of rectifier is not permissible for DC measurement. |
| Err. INPUT.-VALUE | Value entered for one of the following reference values is outside the permissible limits.<br>Permissible limit values (more details → 3.4.5.1/2):<br>Level reference value: 0 V to ± 1 MV<br>Frequency reference value: 0 Hz to ± 100 MHz<br>Impedance value: 1 mΩ to 1 MΩ<br>CORR ATT value: -120 dB to + 120 dB<br>Time for measurement speed<br>SYNC and INTV: 10 ms to 60 ms<br>Lower and upper<br>full-scale values: 1E-18 to 1E + 12 |
| Err. SETUP-Nr. | Location number of complete setup not permissible.<br>Permissible number: 0 to 9 |
| Err. IEC-ADR | IEC-bus address not permissible.<br>Permissible address: 0 to 30 |
| DEVICE-Err. = abcd | Hardware error, abcd → 3.5.10.3 |
| NO OPTION URE3-B2 | In/Out Option URE3-B2 not installed |
| CHAR. MISPLACED<br>CHAR. ILLEGAL<br>COMMAND ILLEGAL<br>COMMAND UNCLEAR<br>VALUE OUT OF RANGE<br>UNIT ILLEGAL<br>UNIT UNCLEAR<br>COMMAND ERROR xxx | These error messages occur only in IEC-bus operation!<br>→ 3.5.10.3 Error Register<br><br>xxx: Error number from error register → 3.5.10.3 |

### 3.2.5 Readout of Measurement Result on the Display

In order to indicate particular conditions of operation, the measurement result is represented on the display as follows:

| Level display | Frequency display |
|---|---|
| Complete value blinks<br>RMS 1.2345 mV AC<br>The measurement range is exceeded with RANGE HOLD<br>The measurement accuracy is not reduced → 3.4.3.4 | Complete value blinks<br>1.2345 kHz FRQ<br>Analog hardware overdriven<br>Questionable frequency measurement result |
| Last digit of the value blinks<br>RMS 1.2345 mV AC<br>Measured value is below the range in the case of RANGE HOLD or RANGE FIX:<br>The measurement accuracy decreases rapidly → 3.4.3.4 | Last digit of the value blinks<br>RMS 1.2345 kHz FRQ<br>In the case of frequency measurement via the FRONT input socket, the voltage is below the threshold voltage for the frequency counter circuit:<br>10 dB with RMS, 20 dB with PK. |
| RMS OFLO %V AC<br>The calculated value can no longer be displayed,<br>e.g. A(%V) > 999.99% | |
| RMS UFLO dBV AC<br>The calculated value can no longer be displayed.<br>e.g. Measured value display in dBV, dBu, dBm, dBµV or dB with a measurement level of 0 V. The latter may result in the case of RANGE FIX and a very small input signal | |
| RMS FIXD V AC<br>The measurement range is exceeded in the case of RANGE FIX. → 3.4.3.4, 3.4.10.5 | |
| RMS VOID W AC<br>Level measurement result is invalid.<br>Cause: Measurement range or peak value is extremely exceeded<br>→ 3.4.10.4 | VOID kHz FRQ<br>Frequency measurement result is invalid:<br>• Measuring or reference counter has not counted or overflow<br>→ 3.5.10.4 |
| | -NA- kHz FRQ<br>Frequency measurement result is not available (-NA). |

The representations of measurement result shown above also apply to combined frequency and level display.

## 3.3 Preparation for Measurement

**Avoiding noise pickup:**
In order to avoid errors in measurement due to noise pickup, it is recommended - in particular with small test voltages - that the input signal be applied via a shielded cable.

**Interferences at ground potential:**
- Low-frequency noise (hum) can be suppressed by floating (FLOAT),
- high-frequency noise by grounded connection (GND) of the outer conductor of the BNC input socket (→ 3.2.3.1 FLOAT/GND).

**Suppression of low-frequency noise voltages** (e.g. hum) can be achieved with particular efficiency in the setting RMS using the highpass filter 1000 Hz.

**Suppression of high-frequency noise voltages** is possible using the lowpass filters → 3.4.2.3. Make sure that the AC measuring circuit preceding the filter is not overdriven by excessive noise voltages such as to produce signal distortions. The internal overdrive control of the instrument usually prevents such signal distortions. In exceptional cases, switch off autoranging and select the appropriate measurement range manually (→ 3.4.3.2, 3.4.3.3).

**With DC measurement, thermo-electric voltages** may occur when contacting the device under test and at the input socket of the instrument. This effect usually disappears after a few minutes when the temperature has been equalized.

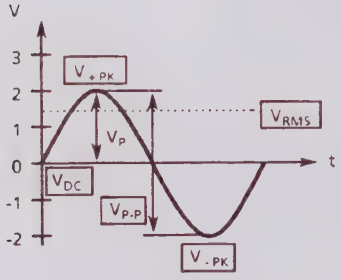
Noise voltages can be eliminated by computation!
→ 3.4.4 Offset Voltage Suppression

**Basics of voltage measurement:**
Using sinusoidal signals by way of example (of course any signal shapes can be measured).

Signal without DC component

$$V_{RMS} = \left( \frac{V_P}{\sqrt{2}} \right)$$

RMS value of sinosoidal signals




| Mode of meas. / Detector | AC | AC + DC | DC |
|---|---|---|---|
| RMS | 1.4142 V | 1.4142 V | 0 V (Detector inefficient) |
| +PK | 2 V | 2 V | |
| -PK | -2 V | -2 V | |
| P-P | 4 V | 4 V | |

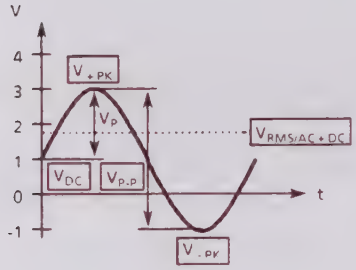
□ = Displayable measurement results

The following applies to sinusoidal signals:

Signal with DC component

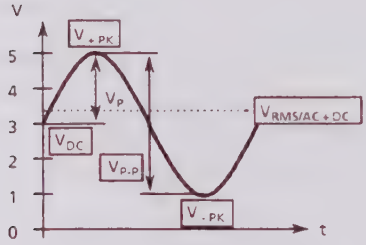
$$V_{RMS/AC+DC} = \sqrt{V_{DC}^{\,2} + \left(\frac{V_P}{\sqrt{2}}\right)^2}$$

RMS value of sinusoidal signals with DC component




| Mode of meas. / Detector | AC | AC + DC | DC |
|---|---|---|---|
| RMS | 1 4142 V | 1 732 V | 1 V (Detector inefficient) |
| + PK | 2 V | 3 V | |
| - PK | -2 V | -1 V | |
| P-P | 4 V | 4 V | |

Signal with large DC component




| Mode of meas. / Detector | AC | AC + DC | DC |
|---|---|---|---|
| RMS | 1 4142 V | 3 3166 V | 3 V (Detector inefficient) |
| + PK | 2 V | 5 V | |
| - PK | -2 V | 1 V | |
| P-P | 4 V | 4 V | |

**Note:**
Depending on the polarity of the DC component,
- $V_{+PK}$ may assume negative values,
- $V_{-PK}$ positive values.

□ = Displayable measurement results

## 3.4 Description of Operating Functions

### 3.4.1 Measuring Functions

Due to its various modes of measurement, the URE3 can be viewed in different ways:

**A universal measuring instrument**
with a multitude of possible settings:

In this operating mode, the modes of measurement AC, DC, AC + DC as well as the rectifiers RMS and Peak can be set and combined at will without affecting other settings such as filter, measurement speed, display unit, etc.

***Each change in the mode of measurement or the rectifier (AC or AC + DC ↔ DC, RMS ↔ PEAK) always causes RANGE AUTO to be selected and the offset suppression ZERO to be switched off, except if MODE MEMORY is activated.***

This mode is active following RCL 0 (basic instrument setup).

**Manual operation:**

**IEC-bus operation:**

```
IECOUT 20, "MODE:MEMORY:OFF"
```

**Four individual special measuring instruments:**

- AC measuring instrument (AC + DC is included)
- DC measuring instrument
- RMS measuring instrument
- PEAK measuring instrument

Each time the mode of measurement (AC or AC + DC ↔ DC) or the rectifier (RMS ↔ PK) is changed, the complete instrument setup is stored internally in a non-volatile memory and the last valid setting pertaining to the desired mode of measurement or detector is recalled. Thus, all instrument setups such as filter, measurement speed, display unit, range, etc. are maintained for the desired mode of measurement or detector even after changing mode or detector.

This operating mode can be compared to storing and recalling of complete instrument setups (→ 3.2.3.12), except that it is performed automatically with each change in measurement mode or detector.

**Manual operation:**

**IEC-bus operation:**

```
IECOUT 20, "MODE:MEMORY:ON"
```

### 3.4.1.1 AC Measurement with Rms-responding Rectification (RMS)

The URE3 measures the true rms value of AC voltages of any signal shapes at the square-law characteristic of an FET rectifier in the range from 50 µV to 300 V with a resolution of 1 µV in the most sensitive measurement range.

**When measuring dangerous contact voltages >50 V observe the relevant safety regulations.**

**Crest factor:**

The crest factor is defined as

$$C = \frac{|greatest\ positive\ or\ negative\ peak\ value|}{rms\ value}$$

For sinusoidal AC voltages, the crest factor is $\sqrt{2}$.

The instrument measures signals with

- Crest factors 1 to 5 with the highest possible resolution
- Crest factors 5 to 7 with the highest possible resolution or with a somewhat lower resolution if, due to the signal shape, the next less sensitive measurement range is to be selected,
- Crest factors >7 with a lower resolution, as less sensitive measurement ranges are to be selected.

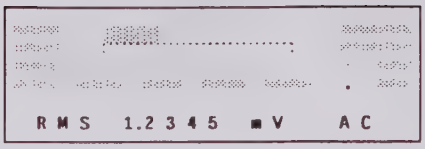
The lower the rms value of the test voltage is relative to the rated voltage of the measurement range, the greater is the permissible crest factor.

**Bandwidth:**

The bandwidth for the AC/RMS measuring function is greater than 30 MHz and can be reduced by selecting the lower cutoff frequency 10 Hz, 100 Hz or 1000 Hz and the upper cutoff frequency 20 kHz, 100 kHz or 1 MHz (→ 3.4.2.2, 3.4.2.3).

**Manual operation:**

Readout on the display:




**IEC-bus operation:**

```
IECOUT 20,"MODE:FUNCTION:AC; DETECTOR:RMS"
```

### 3.4.1.2 AC + DC Measurement with Rms-responding Rectification (RMS)

The URE3 carries out alternately an AC and a DC measurement and reads out the rms value of the AC + DC voltage obtained by square-law addition of the two components. For the AC component, the lower and the upper cutoff frequency can be selected as with pure AC measurements.

**When measuring dangerous contact voltages >50 V observe the relevant safety regulations.**

**Manual operation:**

Readout on the display:

**IEC-bus operation:**

```
IECOUT 20,"MODE:FUNCTION:ACDC; DETECTOR:RMS"
```

### 3.4.1.3 AC Measurement with Peak-responding Rectification (PK)

The instrument measures the peak value of the AC coupled signal in the frequency range 10 Hz to 10 MHz.

**When measuring dangerous contact voltages >50 V observe the relevant safety regulations.**

Spectral components >10 MHz distort the shape of the signal and produce measuring errors.

For non-sinusoidal input voltages (pulse signals), the following signal distortions may occur in a peak-value measurement (PK):

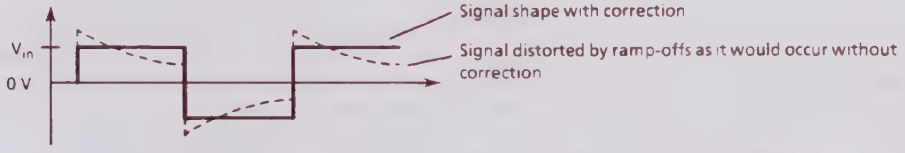
- Ramp-offs with signals the fundamental (pulse repetition frequency) of which is near the lower band limits (HP) → 3.4.2.2:
  A special correction circuit causes the signal distortion to be eliminated as far as possible. In order to obtain the same minimum signal distortion without using a correction circuit, lower-frequency highpass filters would have to be cut into the signal path which would increase the transient time and thus reduce the measurement speed.

- Overshoots near the upper band limits (LP) with peak-value measurements using the:

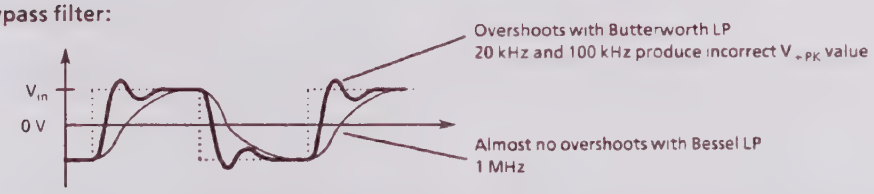
  - 1-MHz lowpass filter (→ 3.4.2.3),
    a high measurement accuracy is obtained, as the lowpass filter used is a Bessel filter that is particularly suited for peak-value measurements, producing hardly any unwanted overshoots due to its linear phase response.
  - 20-kHz and 100-kHz lowpass filters (→ 3.4.2.3)
    cause greater measuring errors, as they are Butterworth lowpass filters with a steep amplitude frequency response. These filters should not be used for peak-value measurements with pulse-shaped signals.

**Influence of the filter on the signal shape:**

**Highpass filter:**




**Lowpass filter:**


$V_{in}$
0 V
Overshoots with Butterworth LP
20 kHz and 100 kHz produce incorrect $V_{+PK}$ value
Almost no overshoots with Bessel LP
1 MHz

If the signal shape is characterized by frequent occurrence of peak values, a high measurement speed can be selected; if peak values occur rarely, a low measurement speed has to be selected.

The measurement speed of a free-running measurement (readout of measurement result on the display not triggered) is only determined by the SPEED selected. A measurement triggered via IEC bus or external trigger input is not only determined by SPEED, but also by the highpass filter selected (→ 3.4.2.1).

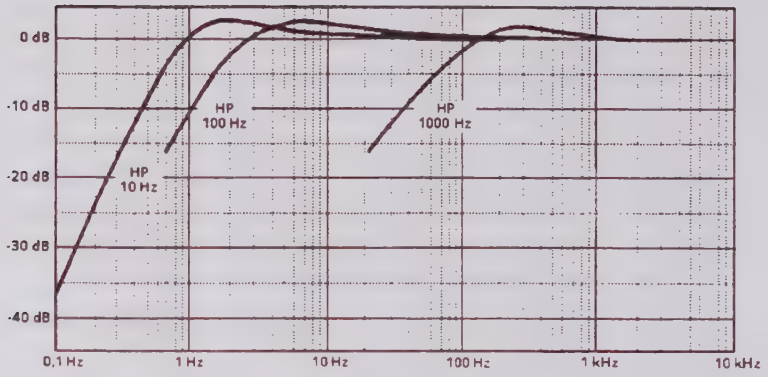



Fig. 3-4 Frequency response with AC peak measurement

**Manual operation:**

Readout on the display

**IEC-bus operation:**

```
IECOUT 20,"MODE:FUNCTION:AC"
IECOUT 20,"DETECTOR:PEAK_POS" or "DETECTOR:PEAK_NEG" or "DETECTOR:PEAK_PEAK"
```

### 3.4.1.4 (AC + DC) Measurement with Peak-responding Rectification (PK)

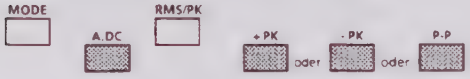
The URE3 measures the peak value of any signal with DC component.

**When measuring dangerous contact voltages >50 V observe the relevant safety regulations.**

The input signal is DC coupled with the meter rectifier.

Due to the DC coupling, errors in measurement caused by ramp-offs in the case of low-frequency pulse signals can be excluded.

Manual operation:




Readout on the display:

IEC-bus operation:

```
IECOUT 20,"MODE:FUNCTION:ACDC"
IECOUT 20,"DETECTOR:PEAK_POS" or "DETECTOR:PEAK_NEG" or "DETECTOR:PEAK_PEAK"
```

### 3.4.1.5 DC Measurement

The URE3 measures DC voltages between 0 and 300 V with a resolution of 1 µV in the most sensitive measurement range.

**When measuring dangerous contact voltages >50 V observe the relevant safety regulations.**

Superimposed AC voltages can be suppressed by means of a higher-order lowpass filter selected with the measurement speed (→3.4.2.1).

If the measuring path is overloaded during a DC measurement by a possibly superimposed AC voltage, automatically a less sensitive measurement range is set by the instrument.

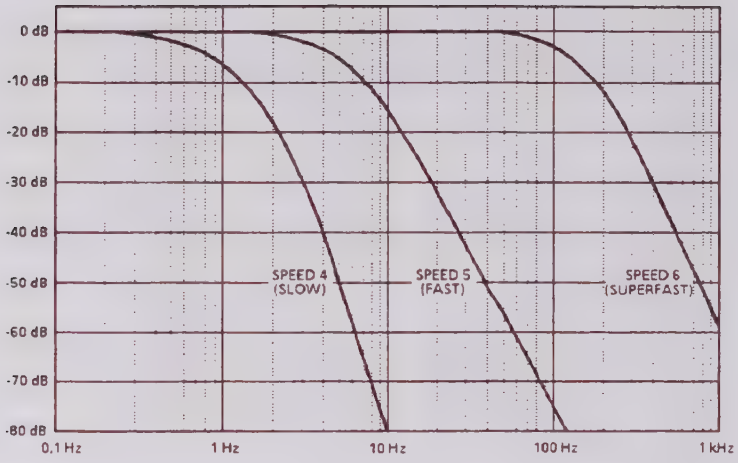



Fig. 3-5 Frequency response of the DC measuring circuit as a function of the measurement speed

**Manual operation:**

Readout on the display:

**IEC-bus operation:**

```
IECOUT 20,"MODE:FUNCTION:DC"
```

### 3.4.1.6 Frequency Measurement

In addition to the rms and peak value of the signal applied, the frequency can also be measured. The frequency and the level can be displayed simultaneously → 3.2.3.1.

#### 3.4.1.6.1 Frequency Input at the Front

The frequency counter derives the frequency from the input signal at the BNC socket at the front of the instrument.

***The frequency of the test signal is measured after the highpass and lowpass filters so that unwanted signal components can be suppressed by these filters.***

Too small or distorted signals may cause an error in the frequency measurement. In this case, the rear frequency input (included in In/Out Option URE3-B2) should be used with an external control signal (→ 3.4.1.6.2).

Frequency measurements are possible in all measurement modes (except in the DC measurement mode) and with all HP and SPEED settings.

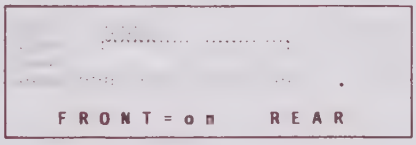
A frequency measurement result is displayed when the frequency counter circuit triggers or a signal periodicity for test frequencies < 10 Hz has been determined by digital signal processing (HP OFF with measurement speed INTV TIME, SYNC TIME, SYNC 10 or SYNC).

**Exception:**

With test frequencies >10 Hz, a stable signal period can no longer be determined by digital signal processing and the message LOCKED in the display is extinguished! Nevertheless, a stable frequency measurement result can be displayed via the frequency counter circuit.

**Manual operation:**

Readout on the display:




The current setting is marked by " = on" in the menu line.

**IEC-bus operation:**

```
IECOUT 20,"MODE:FRQIN:FRONT"
```

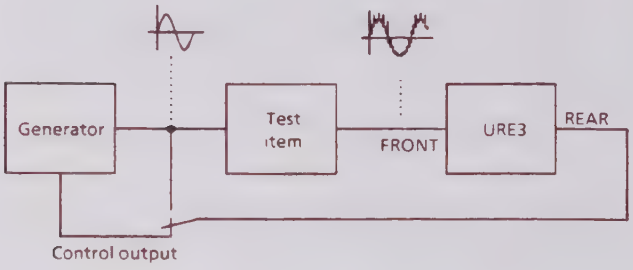
### 3.4.1.6.2 Rear Frequency Input (included in In/Out Option URE3-B2)

The BNC input socket attached to the rear panel and designated as FREQ permits an external control signal to be applied e.g. with TTL level.

This method is used if the test signal applied at the front is attenuated or distorted by the test item in such a way that

- the frequency display indicates unclear or incorrect frequency values,
- the frequency response cannot be corrected properly,
- the DC2FRQ output does not output a proper, frequency-dependent level.

Frequency measurement via the rear input FREQ is possible with any measurement speed (INTV TIME, SYNC TIME, SYNC 10, SYNC 1, SLOW, FAST, SUPERFAST) using the frequency counter circuit for frequencies >0.1 Hz.




**Manual operation:**

Readout on the display:

The current setting is marked by " = on" in the menu line.

**IEC-bus operation:**

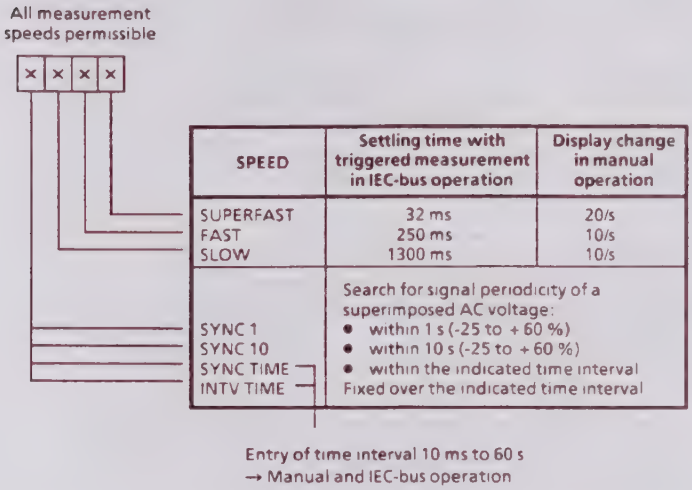
```
IECOUT 20,"MODE:FRQIN:REAR"
```

### 3.4.2 Measurement Speed, Band Limits

#### 3.4.2.1 Measurement Speed

**Measurement mode DC:**

SPEED can be regarded as a display filter to ensure a stable reading. The most stable reading can be obtained with the lowest measurement speeds INTV TIME or SYNC TIME..

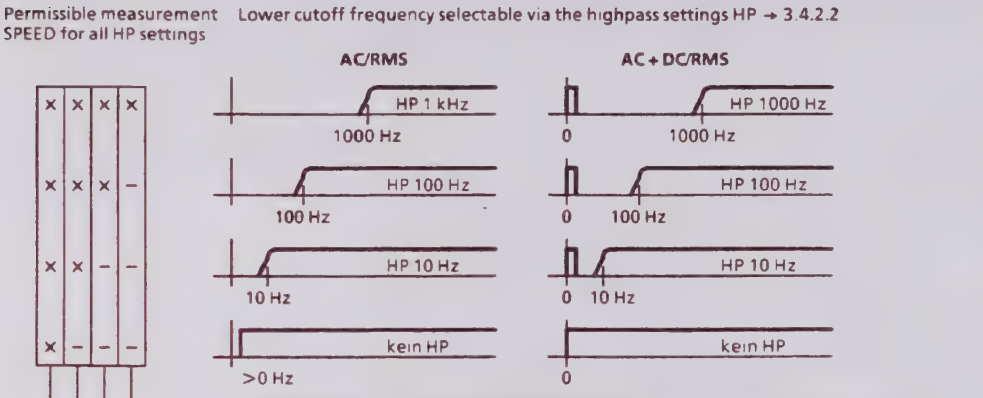

All measurement speeds permissible
× × × ×
SPEED
Settling time with triggered measurement in IEC-bus operation
Display change in manual operation
SUPERFAST 32 ms 20/s
FAST 250 ms 10/s
SLOW 1300 ms 10/s
Search for signal periodicity of a superimposed AC voltage:
SYNC 1 • within 1 s (-25 to + 60 %)
SYNC 10 • within 10 s (-25 to + 60 %)
SYNC TIME • within the indicated time interval
INTV TIME Fixed over the indicated time interval
Entry of time interval 10 ms to 60 s
→ Manual and IEC-bus operation

If the message LOCKED is indicated on the display, a signal periodicity has been found within the tolerance limits.

Superimposed AC voltages are suppressed by means of a higher-order lowpass filter selected with the measurement speed. The lower the selected measurement speed, the lower is the cutoff frequency of the lowpass filter that filters the DC voltage of the DC measuring path, and the greater is the suppression of AC voltages.

**Measurement mode AC/RMS and AC + DC/RMS:**

SPEED can be regarded as a display filter to ensure a stable reading. The most stable reading is obtained with the lowest measurement speeds INTV TIME or SYNC TIME.




| SPEED | Settling time with triggered measurement in IEC-bus operation | Display change in manual operation |
|---|---|---|
| SUPERFAST | 32 ms | 20/s |
| FAST | 250 ms | 10/s |
| SLOW | 1300 ms | 10/s |

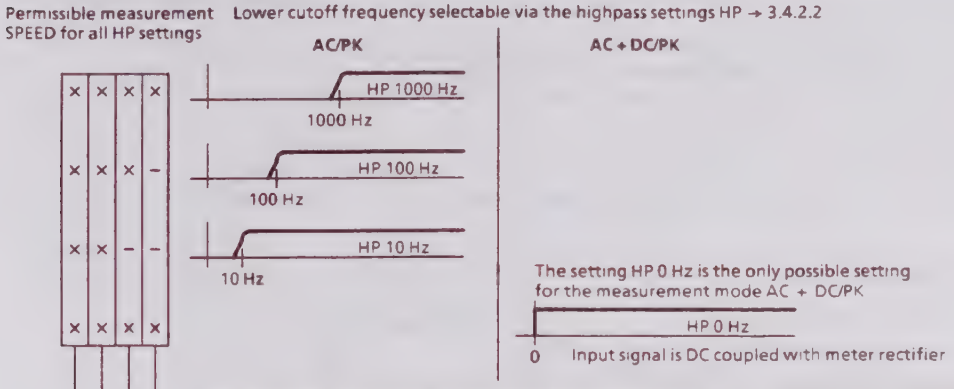
| SPEED | Determination of rms value over a time interval |
|---|---|
| SYNC 1 | with search for a signal periodicity<br>• within 1 s (-25 to + 60 %) |
| SYNC 10 | • within 10 s (-25 to + 60 %) |
| SYNC TIME | • within the indicated time interval (-25 to + 60 %) |
| INTV TIME | Fixed over the indicated time interval |

Entry of time interval 10 ms to 60 s
→ Manual and IEC-bus operation

If the message LOCKED is indicated on the display, a signal periodicity has been found within the tolerance limits.

**Measurement mode AC/PK and AC + DC/PK measurement:**

SPEED determines the period of observation for searching the maximum of the signal applied.


Permissible measurement SPEED for all HP settings
Lower cutoff frequency selectable via the highpass settings HP → 3.4.2.2
AC/PK
AC + DC/PK
HP 1000 Hz
1000 Hz
HP 100 Hz
100 Hz
HP 10 Hz
10 Hz
The setting HP 0 Hz is the only possible setting for the measurement mode AC + DC/PK
HP 0 Hz
0
Input signal is DC coupled with meter rectifier

| SPEED | Period of observation for searching the maximum | Display change in manual operation | Test frequency limit for stable display with AC + DC/PK |
|---|---|---|---|
| SUPERFAST | 20 ms | 20/s | 1 kHz |
| FAST | 30 ms | 10/s | 50 Hz |
| SLOW | 150 ms | 5/s | 10 Hz |
| INTV 1 | 1 s | 1/s | 1 Hz |
| INTV 10 | 10 s | 0.1/s | 0.1 Hz |
| INTV TIME | fixed over indicated time interval | | |

Entry of time interval 10 ms to 60 s
→ Manual and IEC-bus operation

*Measurement speed of a triggered measurement* = *Period of observation* + *Settling time of HPs* + *Internal processing time*

| SPEED | Measurement speed of a triggered measurement | | | |
|---|---|---|---|---|
| | Meßmode AC/PK | | | Meßmode AC + DC/PK |
| | HP 1000 | HP 100 | HP 10 | |
| SUPERFAST | 65 ms | --- | --- | 65 ms |
| FAST | 80 ms | 300 ms | --- | 80 ms |
| SLOW | 200 ms | 420 ms | 1300 ms | 200 ms |
| INTV 1 | 1 s | 1.3 s | 2.2 s | 1 s |
| INTV 10 | 10 s | 10.5 s | 11.2 s | 10 s |
| INTV TIME | xxx ms | xxx ms | xxx ms | xxx ms |

xxx: Depending on the selected period of observation

**Frequency measurement:**

SPEED determines the gate time for the frequency measurement which extends over at least 10 signal periods.

| SPEED | Gate time | appropriate signal frequency | Display change |
|---|---|---|---|
| SUPERFAST | 10 ms | ≥ 1000 Hz | 20/s |
| FAST | 100 ms | ≥ 100 Hz | 10/s |
| SLOW | 1 ms | ≥ 10 Hz | 1/s |

Measurement speed for measurement triggered via IEC bus:

| SPEED | FRONT input | | | REAR input |
|---|---|---|---|---|
| | HP 1000 | HP 100 | HP 10 | |
| SUPERFAST | 80 ms | — | — | 40 ms *) |
| FAST | 250 ms | 400 ms | — | 150 ms *) |
| SLOW | 1300 ms | 1400 ms | 2300 ms | 1100 ms *) |
| SYNC 1<br>SYNC 10<br>SYNC TIME<br>INTV TIME | The frequency measurement result is displayed if the frequency counter circuit triggers or the digital signal processing determines a signal periodicity. | | | |

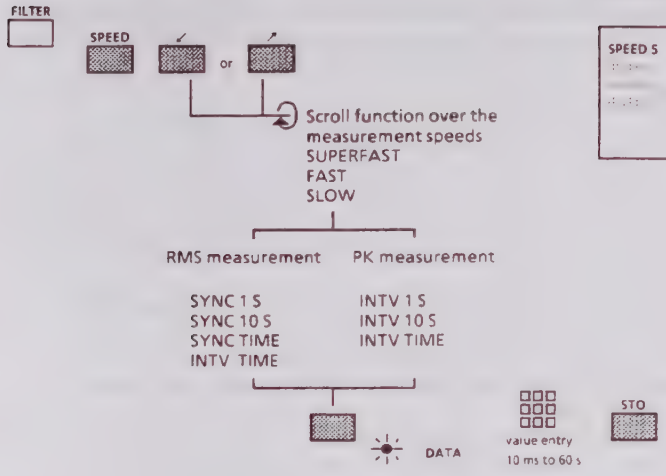
*) The measuring times indicated for the REAR input are pure frequency measuring times. The measured value is not read out before the voltage measurement performed simultaneously is also finished.

Depending on the measurement mode (AC, AC + DC), the detector (RMS, PK) and the lower cutoff frequency (HP) selected, these measuring times may increase.

***As shown in the preceding graphs, the measurement speed is coupled with the lower cutoff frequency (HP). If a SPEED selection is made which, according to the table above, is not permissible for the selected HP, the HP is set to the next higher value.***

*Example:* The current setting is SLOW with HP 10 Hz. SPEED is changed to fast. HP is changed accordingly to 100 Hz (as can be seen from the permanent indication on the display).

**Manual operation:**




Readout on the display:

| | | |
|---|---|---|
| SYNC 1 S: | with RMS measurement: | Search for a signal periodicity within 1 s (-25 to + 60 %) |
| INTV 1 S: | with PK measurement: | Period of observation 1 s |
| SYNC 10 S: | with RMS measurement: | Search for a signal periodicity within 10 s (-25 to + 60 %) |
| INTV 10 S: | with PK measurement: | Period of observation 10 s |
| SYNC TIME: | with RMS measurement: | Search for a signal periodicity within the specified time interval (-25 to + 60 %) |
| INTV TIME: | | Fixed over the specified time interval. |

└ permits to enter a time between 10 ms and 60 s for determination of the rms or peak value over a time interval.

***In manual operation, the internal transients are indicated due to the fast output of values on the display so that, in particular with low measurement speeds, the influence of signal changes can be observed continually.***

**IEC bus operation:**

```
IECOUT 20,"FILTER:SPEED:SUPERFAST"
          "FILTER:SPEED:FAST"
          "FILTER:SPEED:SLOW"
          "FILTER:SPEED:SYNC1 or INTV1
          "FILTER:SPEED:SYNC10 or INTV10
          "FILTER:SPEED:SYNC dd.dddE±ds"
          "FILTER:SPEED:INTV dd.ddE±dms"
```

*The highest measurement speed is achieved when no additional calculation of measured value is performed. Each of the functions listed below reduces the measurement speed SUPERFAST:*

- *Display unit unequal to V or mV*
- *Common frequency and level display*
- *Analog display*
- *Offset voltage suppression*
- *ATT-CORR switched in*
- *FRQ-CORR switched in*
- *DC outputs active*
- *Header switched in*

→ *3.5.4.2.7*

*In IEC-bus operation, the measurement rates indicated are valid, fully settled individual measurement results and no rapid display changes!*

### 3.4.2.2 Lower Cutoff Frequency (HP)

The selection of the lower cutoff frequency (HP) permits unwanted low-frequency signal components to be suppressed, as well as the measurement speed to be influenced.

**Measurement mode AC/RMS and DC/RMS:**

The lower cutoff frequency can be selected between 1000 Hz, 100 Hz and 10 Hz.

The setting OFF causes processing of the measured value with DC coupling which is implemented by the combination of DSP (Digital Signal Processing) with analog signal evaluation. In the setting OFF, the rms value of the signal is calculated from the result of digital signal processing and analog signal evaluation. The lower cuttoff frequency (HP) is coupled with the measurement speed.

| | SPEED | | | | | | |
|---|---|---|---|---|---|---|---|
| | INTV TIME | SYNC TIME | SYNC 10 | SYNC 1 | SLOW | FAST | SUPERFAST |
| HP OFF | × | × | × | × | --- | --- | --- |
| HP 10 Hz | × | × | × | × | × | --- | --- |
| HP 100 Hz | × | × | × | × | × | × | --- |
| HP 1000 Hz | × | × | × | × | × | × | × |

×: Permissible
---: Not permissible

**Measurement mode AC/PK:**

The lower cutoff frequency can be selected between 1000 Hz, 100 Hz and 10 Hz and is coupled with the measurement speed:

| | SPEED | | | | | |
|---|---|---|---|---|---|---|
| | INTV TIME | INTV 10 | INTV 1 | SLOW | FAST | SUPERFAST |
| HP 10 Hz | × | × | × | × | — | — |
| HP 100 Hz | × | × | × | × | × | — |
| HP 1000 Hz | × | × | × | × | × | × |

×: Permissible
—: Not permissible

**Measurement mode AC + DC/PK:**

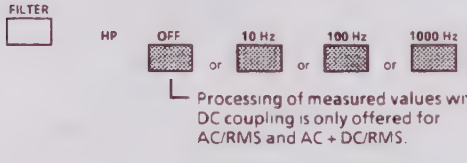
As the input signal is DC coupled with the meter rectifier, the HP menu is not offered for the measurement mode AC + DC/PK.

If a HP setting is made which, according to the table above, is not permissible for the selected measurement speed, SPEED is set to the next lower value.

*Example:* Current setting is HP 100 Hz with SPEED = FAST
HP is changed to 10 Hz.
SPEED is changed to SLOW (as can be seen from the permanent indication on the display).

***Peak-value measurement (PK) of non-sinusoidal input voltages (pulse signals) with the fundamental near the lower band limits (HP) → 3.4.1.3.***

**Manual operation:**




Readout on the display:

**IEC-bus operation:**

```
IECOUT 20,"FILTER:HP 1000Hz" or "FILTER:HP 100Hz" or "FILTER:HP 10Hz"
```

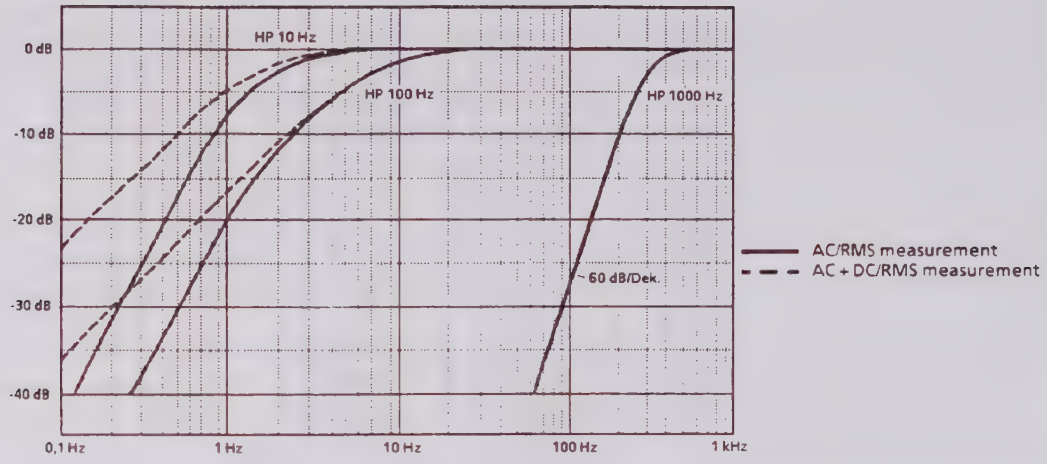



Fig. 3-6 Frequency response of highpass filters with AC/RMS and AC + DC/RMS measurement

### 3.4.2.3 Upper Cutoff Frequency (LP)

The selection of the upper cutoff frequency (LP) permits unwanted high-frequency signal components to be suppressed efficiently.

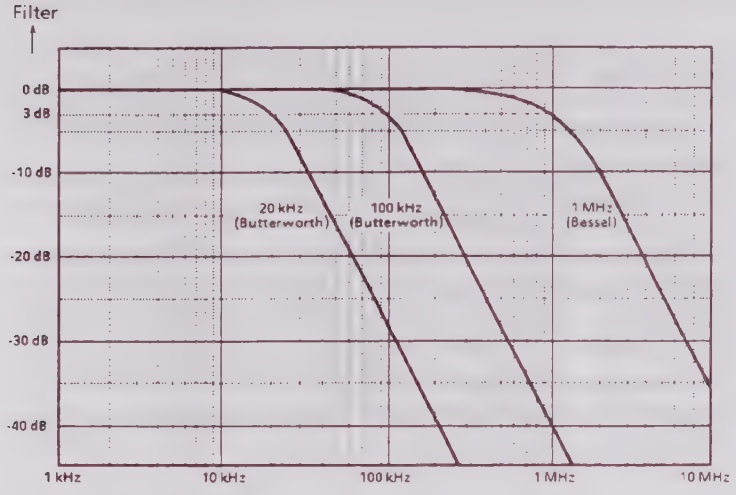



Fig. 3-7 Frequency response of lowpass filters

LP filters:
LP 20 kHz: Butterworth
LP 100 kHz: Butterworth
LP 1 MHz: Bessel

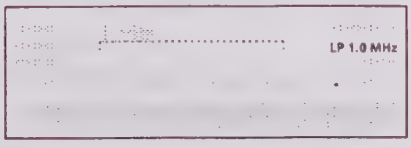
For the measurement modes AC/RMS, AC/PK, AC + DC/RMS and AC + DC/PK, the upper cutoff frequency can be selected between 20 kHz, 100 kHz and 1 MHz.

The LP menu is not offered for the measurement mode DC.

***Non-sinusoidal input voltages (pulse signals) and peak-value measurement (PK) in conjunction with lowpass filters (LP) → 3.4.1.3.***

**Manual operation:**

Readout on the display:




**IEC-bus operation:**

```
IECOUT 20,"FILTER:LP 20kHz" or "FILTER:LP 100kHz" or "FILTER:LP 1MHz"
IECOUT 20,"FILTER:LP:OFF" or "FILTER:LP OFF"
```

### 3.4.3 Selection of Measurement Range

The range selection depends on the measurement mode selected:

| Rated range value | IEC bus designation | AC/RMS<br>AC + DC/RMS | AC/PK<br>AC + DC/PK | DC |
|---|---|---|---|---|
| 1 mV | ... 1MV or 1mV" | × | --- | — |
| 3 mV | ... 3MV or 3mV" | × | × | — |
| 10 mV | ... 10MV or 10mV" | × | × | × |
| 30 mV | ... 30MV or 30mV" | × | × | — |
| 100 mV | ... 100MV or 100mV" | × | × | × |
| 300 mV | ... 300MV or 300mV" | × | × | — |
| 1 V | .. 1V | × | × | × |
| 3 V | .. 3V | × | × | — |
| 10 V | ... 10V | × | × | × |
| 30 V | ... 30V | × | × | — |
| 100 V | ... 100V | × | × | × |
| 300 V | ... 300V | × | × | × |
| 1000 V | ... 1000V | --- | × | — |

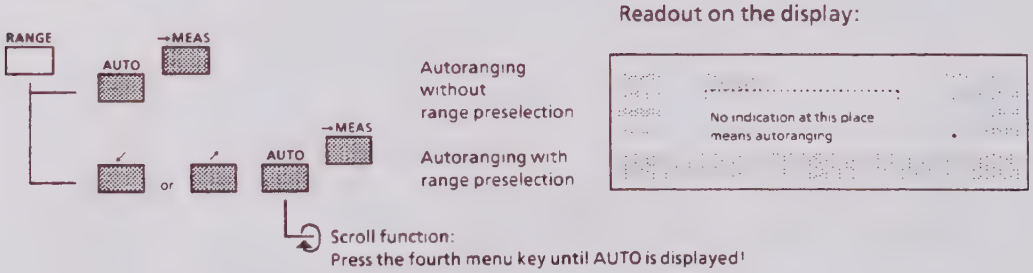
×: Possible
---: Not possible

#### 3.4.3.1 Autoranging

Autoranging permits any voltage within the specified range (→ data sheet) to be applied to the input socket without causing damage to the instrument.

The measurement range appropriate for the applied signal is selected at a switching rate that depends on the measurement speed selected. There are cases, however, where it is preferable to switch off autoranging (→ sections 3.4.3.2 and 3.4.3.3). If AUTO range is set with range preselection, autoranging is cut in with the indicated range, which may considerably accelerate detection of the range appropriate for the currently applied test signal so that the measurement result will be available faster.

**Manual operation:**




**IEC-bus operation:**

```
IECOUT 20,"RANGE:AUTO"
IECOUT 20,"RANGE:AUTO 1MV" ... "RANGE:AUTO 1000V"
```

Autoranging without range preselection
Autoranging with range preselection
Range designations → 3.4.3

### 3.4.3.2 Switching Off Autoranging with RANGE HOLD

With RANGE HOLD set, the selected measurement range is maintained as the lowest range; when the range is exceeded, the URE3 changes over to the next higher measurement range.

**After the excessive voltage has been removed, the instrument returns to the original range.**

**Exception:**
*After* the measurement range has been exceeded, it may occur that the test signal is measured in the hysteresis range of the next higher measurement range and is thus displayed with a lower resolution. This can be avoided by means of the RANGE FIX setting (→ 3.4.3.3).

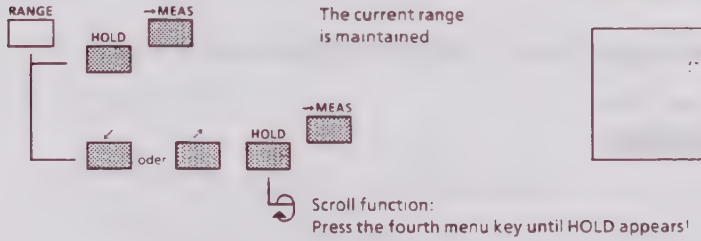
Maintaining an automatically selected measurement range is useful if the input voltage is shortly removed and unnecessary switching to the most sensitive measurement range is to be avoided.

Switching off autoranging may also become necessary if high noise voltages are to be suppressed by a lowpass filter (→ 3.4.2.3). Since the autoranging facility measures the signal after the lowpass filter, the suppressed noise components of the signal might cause the input amplifier to be overdriven and the test signal to be invalidated. As a rule of thumb, the components rejected by the filter should not be greater than the components passed.

If the input circuits are overdriven, a less sensitive measurement range is to be selected by means of RANGE HOLD.

***Each change in the mode of measurement or the rectifier (AC or AC + DC ↔ DC, RMS ↔ PEAK) always causes RANGE AUTO to be selected, except if MODE MEMORY is activated (→ 3.4.1).***

**Manual operation:**




Readout on the display:

**IEC-bus operation:**

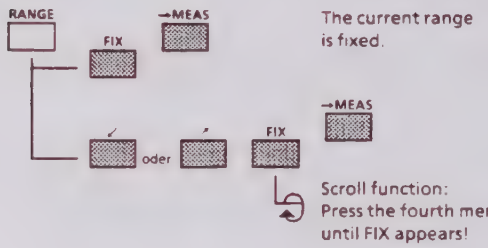
```
IECOUT 20,"RANGE:HOLD"
IECOUT 20,"RANGE:HOLD 1MV" ... "RANGE:HOLD 1000V"
```

Range designations → 3.4.3

### 3.4.3.3 Switching Off Autoranging with RANGE FIX

The setting RANGE FIX maintains the selected measurement range in order to avoid selection of the next higher measurement range when spikes are superimposed on a signal. Thus, it prevents the instrument from continuing the measurement in the higher measurement range (due to hysteresis) after removal of the spike although the measurement accuracy would be higher in the range below. For applications, refer to 3.4.3.2.

**Manual operation:**




Readout on the display:

The display of RANGE HOLD indicates both RANGE HOLD and RANGE FIX.

***Each change in the mode of measurement or the rectifier (AC or AC+DC ↔ DC, RMS ↔ PEAK) always causes RANGE AUTO to be selected, except if MODE MEMORY (→ 3.4.1) is activated.***

**IEC-bus operation**

```
IECOUT 20,"RANGE:FIX"
IECOUT 20,"RANGE:FIX 1MV" ... "RANGE:FIX 1000V"
```

Range designations → 3.4.3

### 3.4.3.4 Display and Measurement Accuracy with the Value Below or Above the Range

Value is below the range:

When the measured value is below the range, the measurement accuracy decreases fast if,

- with AC measurement, the measurement result is less than 30 % of the nominal value and,
- with DC measurement, the measurement result is less than 10 % of the nominal value.

**Manual operation:**

Readout on the display:

Last digit of the value blinks

**IEC-bus operation:**

With the header enabled ("HEADER:ON"), the first two letters indicate whether the measurement result is valid (→ 3.5.7.1.2):

*Example:* `"UR:AC_:RMS:V__ -dde.dddE+dd"`

`UR` = Under Range

After the measurement result has been retained, the validity of the measurement result can be checked via the error register without SRQ execution:

```
:
IECIN 20,M$: REM Read in measurement result
IECOUT 20,"ERRORS?": REM Query for contents of error register
IECIN 20,ER$: PRINT "Error register: ";ER$
```

Readout on the screen: `"Error register: 65"`

| | d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 |
|---|---|---|---|---|---|---|---|---|
| 65d = 41h = | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |

Error register → 3.5.10.3

= Level value below the range

**Range exceeded with RANGE HOLD:**

The range is exceeded when the measurement result is more than 20% above the nominal value of the set range or, with DC measurement, when the AC measuring path has been overdriven by a superimposed AC voltage. The instrument then sets the next higher measurement range. After the excessive voltage has been removed, the instrument returns to the original measurement range.

**Exception:**
***After*** the measurement range has been exceeded, it may occur that the test signal is measured in the hysteresis range of the next higher measurement range and is thus displayed with a lower resolution. In this case, select RANGE FIX (→ 3.4.3.3).

The measurement accuracy is ***not*** reduced when the range is exceeded in the case of RANGE HOLD.

**Manual operation:**

Readout on the display:

Entire measured value blinks

**IEC-bus operation:**

With the header enabled ("HEADER:ON"), the first two letters indicate whether the measurement result is valid:

*Example:* `"OR:AC_:RMS:V__ -dde.dddE+dd"`

`OR` = Over Range

SRQ execution when no error-free measurement result is available or warning because the optimum measurement range has been violated:

```
:
:
IECOUT 20,"*SRE 32"
IECOUT 20,"*ESE 8"
```

32 = 00100000. Enable ESB bit of status byte register which signals (error) messages of the event status register.

8 = 00001000. Enable the messages Device Dependent Error (DDE) in the event status register.

After an SRQ has occurred:

```
:
:
IECOUT 20,"ERRORS?"
IECIN 20,ER$: PRINT "Error register = ";ER$
```

Readout on the screen: `"Error register: 66"`

| | d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Error register → 3.5.10.3 |
| 66d = 42h = | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | = Level range exceeded |

**Range exceeded with RANGE FIX:**

The measurement result is invalid.

**Manual operation:**

Readout on the display:

The invalid measurement result is identified with OFLO on the display

**IEC-bus operation:**

With the header enabled ("HEADER:ON"), the first two letters indicate whether the measurement result is valid:

*Example:* `"FO:AC_:RMS:V__ -dde.dddE+dd"`

`FO` — Fix Overrange

After the measurement result has been retained, the validity of a measurement result can be checked without SRQ execution via the error register:

```
:
IECIN 20,M$: REM Read in measurement result
IECOUT 20,"ERRORS?": REM Query for contents of error register
IECIN 20,ER$: PRINT "Error register: ";ER$
```

Readout on the screen: `"Error register: 67"`

| | d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Error register → 3.5.10.3 |
| 67d = 43h = | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | = Range exceeded with RANGE FIX |

Further information on the validity of measurement results → 3.5.10.3.

## 3.4.4 Offset Voltage Suppression

### 3.4.4.1 Measuring and Storing the Offset Voltage and Switching on Offset Voltage Suppression

The zero function (offset voltage suppression) is a computed zero correction similar to the mechanical zero adjustment of adjustable coil instruments.

Offset voltage suppression permits

- Suppression of noise voltages in the input circuit - true rms-value, square-law correction
- Suppression of any noise voltage at the input socket, such as hum or RF interference - true rms-value, square-law correction
- Suppression of thermo-electric or offset voltages in the test setup - linear correction.

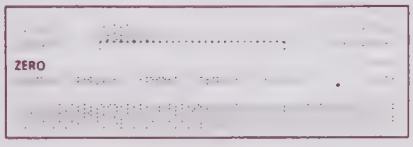
***Note that true rms-value correction provides correct measurement results only if the frequency of the noise voltage to be suppressed is different from that of the test voltage.***

If the unwanted signal to be suppressed and the test signal have the same frequency, the unwanted signal should be stored as reference value by means of the function MEAS→REF and the difference between the unwanted signal and the test signal determined by means of a relative display (e.g. ΔV) (→ 3.4.6.2).

By pressing the menu key EXEC (Execute), the noise voltage to be suppressed is measured, stored and the offset voltage suppression switched in (→ 3.4.4.3).

**Manual operation:**

Readout on the display:




Indicates that offset voltage suppression is switched in.

***If ZERO EXEC is called up with external trigger switched on (→3.4.12), the message "WAITING FOR TRIGGER" is indicated on the display and the ZERO value is only stored after an external trigger.***

**IEC-bus operation:**

```
IECOUT 20,"CORRECTION:ZERO:EXECUTE"
```

### 3.4.4.2 Display Offset Voltage

The measured and stored offset value which is used for calculation of the offset voltage suppression is indicated in the display line.

**Manual operation:**

Readout on the display:

### 3.4.4.3 Switch on/off Offset Voltage Suppression

The calculation of the offset voltage suppression is dependent on the measurement mode (AC, DC, ACDC) and the detector (RMS or PK) selected.

**AC/RMS and ACDC/RMS:**
The offset voltage suppression is accomplished by means of square-law subtraction in order to eliminate noise voltages or inherent noise of the instrument and enable virtually noise-free measurements.

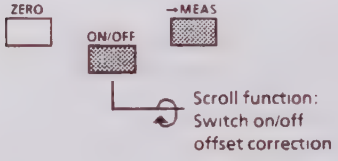
$$Displayed\ value = \sqrt{measured\ value^2 - zero\ value^2}$$

As a result of the calculation of the offset voltage suppression, it may occur that a negative rms value is displayed. This does not indicate that an error is involved, but that the stored zero value is greater than the current measurement result (radicand is negative).

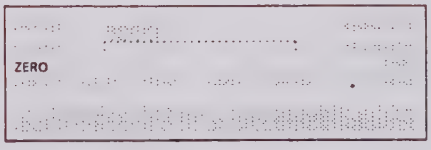
**AC/PK, ACDC/PK, DC:**
The offset voltage suppression is performed linearly.

$$Displayed\ value = measured\ value - zero\ value$$

**Manual operation:**




Readout on the display:




Indicates that the offset voltage suppression is switched in

**IEC-bus operation:**

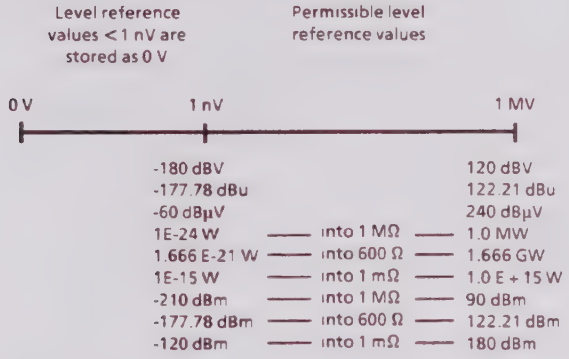
```
IECOUT 20,"CORRECTION:ZERO:ON"
IECOUT 20,"CORRECTION:ZERO:OFF
```

### 3.4.5 Entry of Reference and Impedance for Relative and Power Measurements

#### 3.4.5.1 Level Reference Value

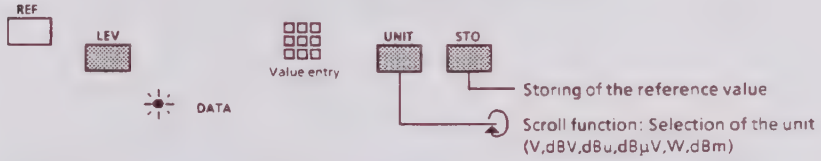
Permissible value range for manual and IEC-bus operation:

| | |
|---|---|
| 0 V to ± 1MV | Level reference values < 1 nV are stored as 0 V |
| dBV, dBu, dBµV: | The input limits are calculated from the voltage limit values. |
| W, dBm: | The input limits are calculated from the voltage limit values and the set impedance value. |


Level reference values < 1 nV are stored as 0 V
Permissible level reference values
0 V
1 nV
1 MV
-180 dBV
-177.78 dBu
-60 dBµV
1E-24 W — into 1 MΩ — 1.0 MW
1.666 E-21 W — into 600 Ω — 1.666 GW
1E-15 W — into 1 mΩ — 1.0 E + 15 W
-210 dBm — into 1 MΩ — 90 dBm
-177.78 dBm — into 600 Ω — 122.21 dBm
-120 dBm — into 1 mΩ — 180 dBm
120 dBV
122.21 dBu
240 dBµV

The following relative units are based on a level reference value:
ΔdB, %V, ΔV, V/Vr, P/Pr, %W, ΔW → 3.2.3.9

**Manual operation:**




Reference values in Watts < 1E-18W are indicated on the display as 0.0000 W!

**IEC-bus operation:**

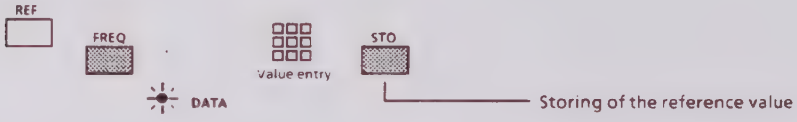
```
IECOUT 20,"REFERENCE:LEV:V 1.2345E-3V"
                              └──── also 0.0012345, 0.0012345V, 1.2345E-3V, 1.2345MV

IECOUT 20,"REFERENCE:LEV:W 1.2345E-6W"
                              └──── also 0.0000012345, 0.0000012345W, 1.2345E-6W,
                                    1.2345UW, 1.2345E-3MW

IECOUT 20,"REFERENCE:LEV:dBV -12.345DBV"
IECOUT 20,"REFERENCE:LEV:dBu -12.345DBU"
IECOUT 20,"REFERENCE:LEV:dBµV -12.345DBUV"
IECOUT 20,"REFERENCE:LEV:dBm -12.345DBM"
                              └──── also -12.345E+0, -1.2345E+1
```

### 3.4.5.2 Frequency Reference Value

Permissible value range for manual and IEC-bus operation:
0 Hz to 100 MHz: Frequency reference values < 1 mHz are stored as 0 Hz

The following relative units are based on a frequency reference value:
F/Fr, %F, ΔHz (→ 3.4.6.4)

**Manual operation:**




**IEC-bus operation:**

```
IECOUT 20,"REFERENCE:FRQ 1.2345E+6"
```

also `1234500, 1234500Hz, 1234E+3Hz, 1234kHz, 1.234MHz`

### 3.4.5.3 Impedance Value

Permissible value range for manual and IEC-bus operation:
1 mΩ to 1 MΩ

The following power units (absolute and relative units) are based on an impedance value:
dBm, W, P/Pr, %W, ΔW (→ 3.4.6.2)

**Manual operation:**

**IEC-bus operation:**

```
IECOUT 20,"REFERENCE:IMP 1234.5"
```

also `1234.5OHM, 1.2345E+3OHM, 1.2345KOHM`

### 3.4.6 Selection of Absolute and Relative Display Units

#### 3.4.6.1 Selection of Absolute Display Units of Level Measurement Result

**Equations:**

$V(V)$

Voltage values < 1 nV are displayed as 0.0000 V

$$P(W) = \frac{V^2}{Z}$$

Power values < 1 aW are displayed as 0 aW. This case may arise when ATT CORR (→ 3.4.7.1) has been specified with a negative dB value, i.e. for a preceding amplifier

$$V(dBu) = 20 \times lg\left(\frac{V}{0.774596}\right)$$

$$V(dBV) = 20 \times lg\left(\frac{V}{1\,V}\right)$$

$$V(dBm) = 10 \times lg\left(\frac{V^2}{Z \times 1\,mW}\right)$$

$$V(dB\mu V) = 20 \times lg\left(\frac{V}{1\,\mu V}\right)$$

A level measurement result is converted into the specified unit and read out in this unit on the display or via IEC bus (→ 3.5.7.1.2).

**Manual operation:**

**IEC-bus operation:**

```
IECOUT 20,"UNIT:LEV:V"
IECOUT 20,"UNIT:LEV:dBu"
IECOUT 20,"UNIT:LEV:dBV"
IECOUT 20,"UNIT:LEV:dBm"
IECOUT 20,"UNIT:LEV:W"
IECOUT 20,"UNIT:LEV:dBuV"
```

In order to obtain maximum measurement rates, the level measurement result should be displayed in volts, since any other unit requires additional computing time in the internal processor.

### 3.4.6.2 Selection of Relative Display Units of Level Measurement Result

The selection of a relative level display unit permits the measurement result to be displayed referred to a level reference value. Entry of the reference values → 3.4.5.1, 3.4.5.3, 3.4.8.

Equations: (D... = Displayed value)

$$D(\Delta dB) = 20 \times lg\left(\frac{V_{meas}}{V_{ref}}\right)$$

$$D(\%V) = \frac{V_{meas} - V_{ref}}{V_{ref}} \times 100\,\%$$

$$D(\Delta V) = V_{meas} - V_{ref}$$

ΔV values <1 nV are displayed as 0.000 V.

$$D(\Delta V) = P_{meas} - P_{ref}$$

ΔW values <1 aW are displayed as 0 aW. This case may arise when ATT CORR (→ 3.4.7.1) has been specified with a negative dB value, i.e. for a preceding amplifier.

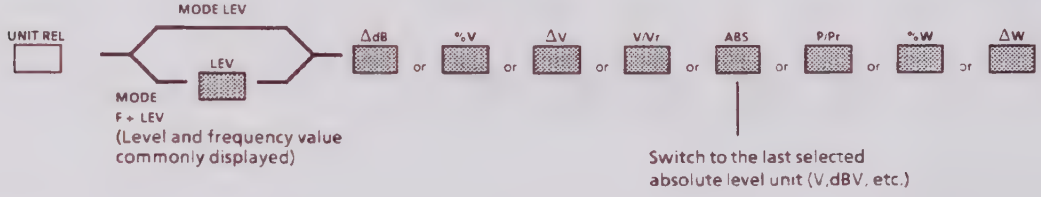
$$D(V/Vr) = \frac{V_{meas}}{V_{ref}}$$

$$D(P/Pr) = \frac{P_{meas}}{P_{ref}}$$

$$D(\%W) = \frac{P_{meas} - P_{ref}}{P_{ref}} \times 100\,\%$$

A level measurement result is converted into the specified relative unit and read out in this unit on the display or via IEC bus (→ 3.5.7.1.2).

Manual operation:




IEC-bus operation:

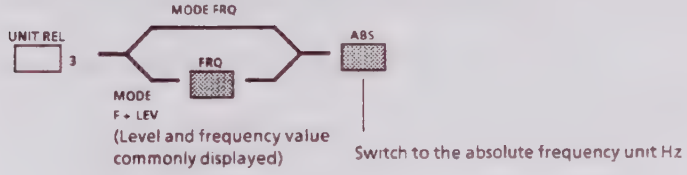
ΔdB: IEC-bus command: `"UNIT:LEV:DdB"`
%V: IEC-bus command: `"UNIT:LEV:DPCV"`
ΔV: IEC-bus command: `"UNIT:LEV:DV"`
V/Vr: IEC-bus command: `"UNIT:LEV:V_Vr"`
P/Pr: IEC-bus command: `"UNIT:LEV:P_Pr"`
%W: IEC-bus command: `"UNIT:LEV:DPCW"`
ΔW: IEC-bus command: `"UNIT:LEV:DW"`

In order to obtain maximum measurement rates, the level measurement result should be displayed in volts, since any other unit requires additional computing time in the internal processor.

### 3.4.6.3 Selecting the Absolute Display Unit Hz of the Frequency Measurement Result

$D(Hz)$ Values <1 mHz are displayed as 0.000 Hz.

**Manual operation:**




**IEC-bus operation:**

IEC-bus command: `"UNIT:FRQ:Hz"`

### 3.4.6.4 Selecting the Relative Display Units of the Frequency Measurement Result

The selection of a relative frequency display unit permits the measurement result to be displayed referred to a reference. Entry of the reference values → 3.4.5.2, 3.4.8.

**Equations:** (D... = Displayed values)

$$D(F/Fr) = \frac{F_{meas}}{F_{ref}}$$

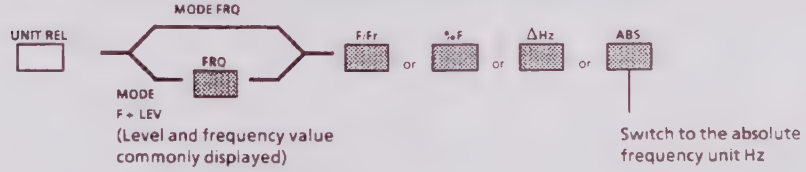
$$D(\%F) = \frac{F_{meas} - F_{ref}}{F_{ref}} \times 100\,\%$$

$$D(\Delta Hz) = F_{meas} - F_{ref}$$

ΔHz values < 1 mHz are displayed as 0.0000 Hz

A frequency measurement result is converted into the specified relative unit and read out in this unit on the display or via IEC bus (→ 3.5.7.1.2).

**Manual operation:**




**IEC-bus operation:**

F/Fr: IEC-bus command: `"UNIT:FRQ:F_FR"`
%F: IEC-bus command: `"UNIT:FRQ:DPCHz"`
ΔHZ: IEC-bus command: `"UNIT:FRQ:DHz"`
ABS: Switch to the frequency unit Hz
IEC-bus command: `"UNIT:FRQ:Hz"`

In order to obtain maximum measurement rates, the frequency measurement result should be displayed in Hz, since any other unit requires additional computing time in the internal processor.

### 3.4.7 Correction of Measurement Result

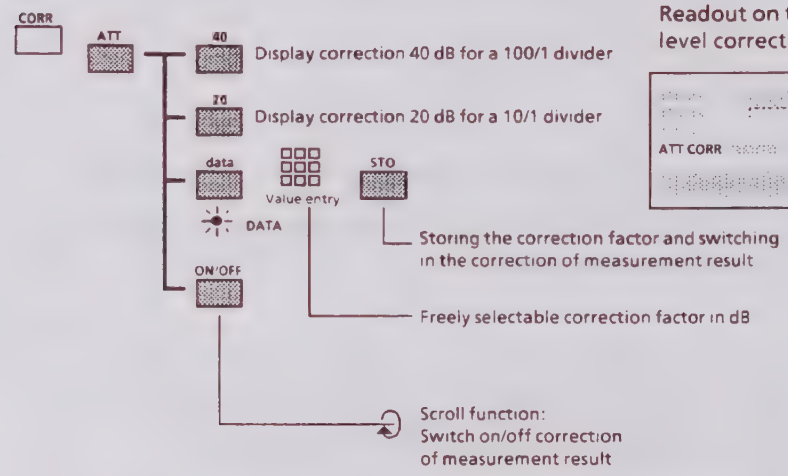
#### 3.4.7.1 Correction of Level Measurement Result (ATT CORR)

The following applies to the freely selectable correction factor in dB:

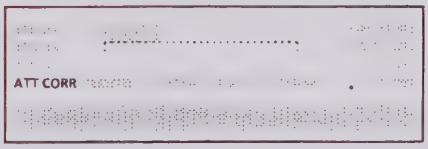
- Positive dB values correct the reading for an attenuator pad or for attenuating probes connected to the test input.
- Negative dB values correct the reading for an amplifier or for amplifying probes connected to the test input.

Permissible range of values for the correction factors with manual operation or IEC-bus operation:
-120 dB to 120 dB

**Manual operation:**




Readout on the display with level correction switched in:




**IEC-bus operation:**

Entry of a correction factor:

```
IECOUT 20,"CORRECTION:ATTENUATION 6.02dB"
```

Switch on/off correction:

```
IECOUT 20,"CORRECTION:ATTENUATION:ON"
IECOUT 20,"CORRECTION:ATTENUATION:OFF"
```

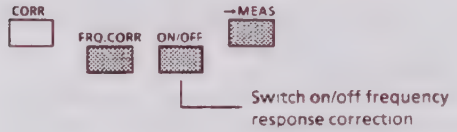
### 3.4.7.2 Switching On/Off Frequency Response Correction (FREQ CORR)

An elaborate frequency response correction guarantees a high measurement accuracy → data sheet.

***It is only effective for the measurement modes ACIRMS and AC+DCIRMS and should preferably be used for sinusoidal signals or signals with low harmonic content.***

In order to obtain maximum measurement rates, the frequency response correction should be switched off, if possible, in order to save additional computing time in the internal processor.

**Manual operation:**




Readout on the display with frequency response correction switched in

***Blinking of the letters FREQ CORR indicates that no frequency count result can be determined by the instrument:***

***Causes:***
- ***measuring or reference counter did not count, or***
- ***overflow of reference counter, or***
- ***overflow of measuring counter***

***→ 3.5.10.4, identification of frequency measurement result, error bits UH, OR and OM***

**IEC-bus operation:**

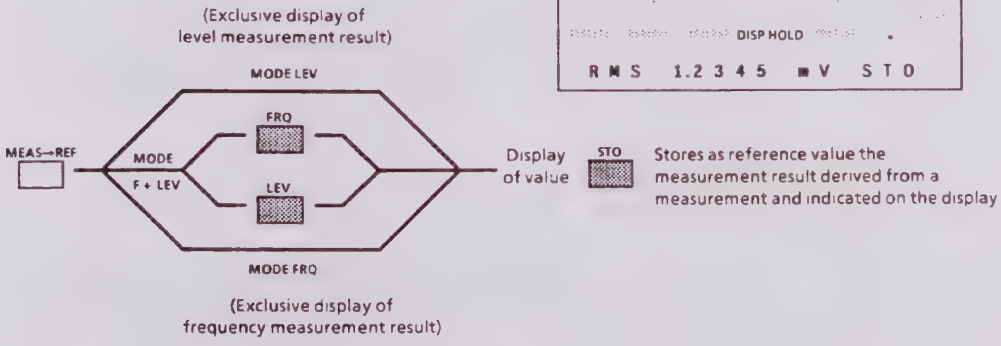
Switch on/off frequency response correction:

```
IECOUT 20,"CORRECTION:FRQRESPONSE:ON"
IECOUT 20,"CORRECTION:FRQRESPONSE:OFF"
```

### 3.4.8 Using a Level or Frequency Measurement Result as Reference Value

**Manual operation:**

Readout on the display:



Calling of this function causes the result of a single measurement to be read out on the display. The message DISP HOLD on the display indicates that the measurement result is maintained and does not change any more.

When the measured value is displayed in the absolute level units V, dBu, dBV, dBm, W, dBµV and the absolute frequency unit Hz, the reference value is read out on the display in this unit.

When the measured value is displayed in the relative level units ΔdB, %V, ΔV, V/Vr, P/Pr, %W, ΔW the respective value in volts is read out on the display as reference value.

When the measured value is displayed in the relative frequency units F/FR, %F, ΔHz , the respective value in Hz is read out on the display as reference value.

If the maintained measurement result is not to be retained in the reference memory, the function MEAS→REF can be aborted by pressing the →MEAS key.

By pressing the STO menu key, the maintained measurement result is transferred with the specified unit to the reference memory as reference value. From then on, all relative display units are based on this new reference value.

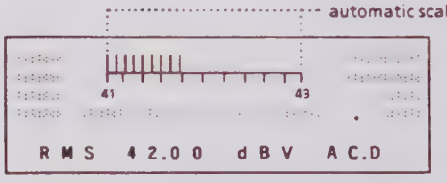
***With activated extreme-value display (→ 3.4.10), the reference-value memory does not store the currently displayed extreme value but the value valid when the MEAS→REF key was actuated.***

**IEC-bus operation:**

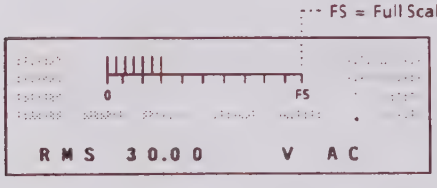
*Program example with R&S Controller PSA:*

```
10 IECOUT 20,"XTRREF?"
```

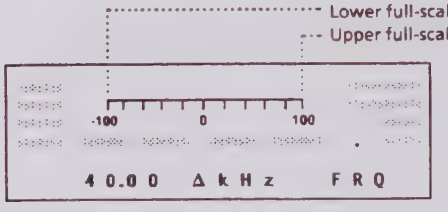
## 3.4.9 Analog Displays (Examples)




Level display as analog bar




Analog display for level volume




Frequency display as single mark,
to be compared with a spectral line.

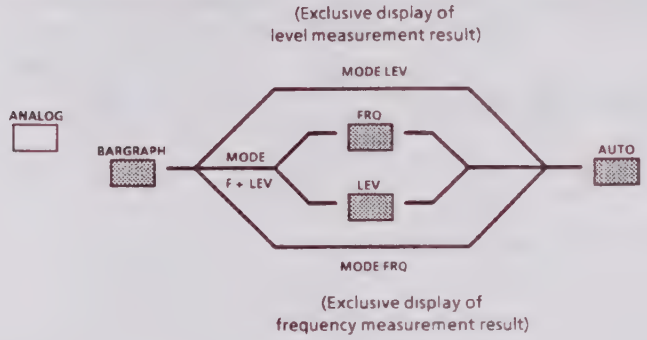
### 3.4.9.1 Analog Display with Automatic Scale (AUTO)

For each displayed value, an appropriate scale with an analog indication is shown on the LCD. **Irrespective of the measurement range, the full-scale values are automatically determined by the displayed value regardless of the absolute or relative unit in which it is displayed.**

The AUTO analog display is suitable for illustration of slight changes in measurement result.

When the reading MODE F + LEV has been selected which means that the level and frequency measurement result are displayed together, the analog representation (analog bar for level display, single mark for frequency display) permits to distinguish clearly between level and frequency.

**Manual operation:**



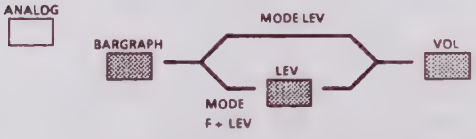

**IEC-bus operation:**

```
IEC OUT 20,"ANALOG:BARGRAPH:LEV:AUTO"
           "ANALOG:BARGRAPH:FRQ:AUTO"
```

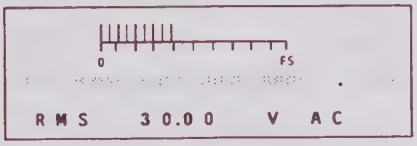
### 3.4.9.2 Analog Display for Level Volume (VOL)

Irrespective of the display unit of a measurement result, the VOL analog display indicates the volume of the selected measurement range. The abbreviation FS of the upper full-scale value denotes the nominal value of the selected range (→ 3.4.3) which can be recalled by pressing the function key RANGE. Whether a measured value is above or below the range limits can be easily recognized by the VOL analog display.

**Manual operation:**




Readout on the display:




Analog display for level volume
FS = Full Scale (nominal value of range)

**IEC-bus operation:**

```
IEC OUT 20,"ANALOG:BARGRAPH:LEV:VOLUME"
```

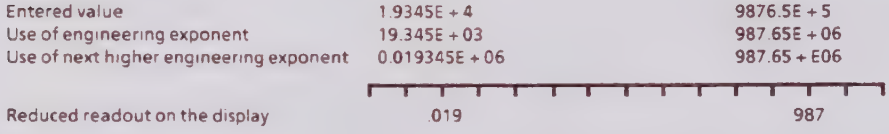
### 3.4.9.3 Analog Display with Selectable Full-scale Values

The freely selectable entry of a non-dimensional quantity as lower and upper full-scale value for level and frequency measurement results with any units permits to maintain the scale and enables a zoom function. This kind of analog display is particularly suited for adjustments where the scale is to be prevented from jumping (as with AUTO analog display) and for the display of measurement results with a high resolution. For this purpose, the full-scale values can be tightened up until the resolution of the analog display equals the resolution of the reading. Further tightening up of the full-scale values does not increase the resolution any more, but produces a sudden variation of the analog display.

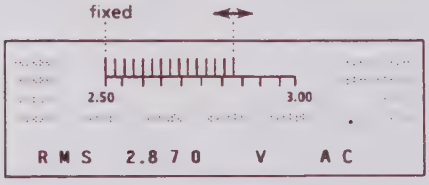
The lower and upper full-scale value can be entered at will. However, only the three-digit mantissa of the full-scale values is shown at the upper and lower end of the scale on the display. If the full-scale values are entered with a 4-digit or 5-digit mantissa the digits that can no longer be displayed are omitted. In order for the mantissa of the input value to correspond exactly to the values read out on the display, it is advisable to enter values with no more than a 3-digit mantissa with the same exponent.

*Example:* Value entry with 3-digit mantissa with same exponent

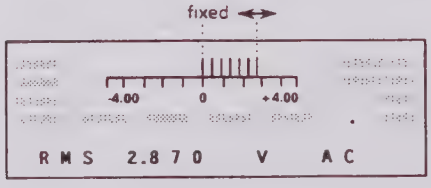
*Example:* Value entry with 5-digit mantissa with different exponent



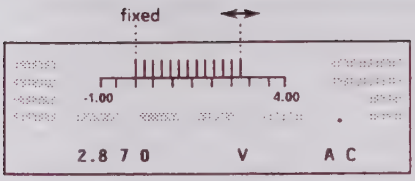

**Various analog displays:**




Zero does not lie within the scale.
The analog display increases from the left full-scale value to the displayed value.




Zero is situated in the middle of the scale.
The analog display increases from zero to the displayed value. Zero of the scale centre is displayed.

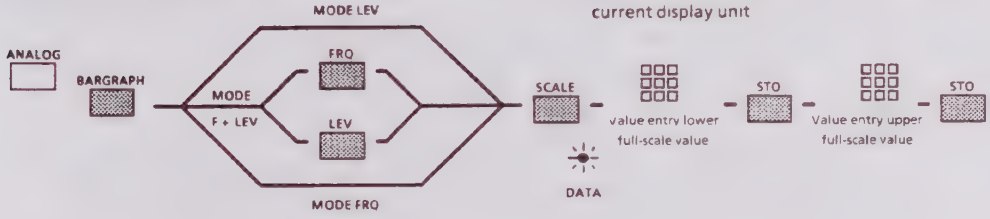



Zero is within the display range, but not in the scale centre. Zero lies at the fixed end of the analog display.

**Manual operation:**

(Exclusive display of level measurement result)

The lower and upper full-scale value is a non-dimensional quantity referring to the current display unit




(Exclusive display of frequency measurement result)

The lower and upper full-scale value is a non-dimensional quantity which refers to the current display unit.

**IEC-bus operation:**

```
IECOUT 20,"ANALOG:BARGRAPH:LEV:SCALE_LOWER ±dd.dddE±d"
          "ANALOG:BARGRAPH:LEV:SCALE_UPPER ±dd.dddE±d"
          "ANALOG:BARGRAPH:FRQ:SCALE_LOWER ±dd.dddE±d"
          "ANALOG:BARGRAPH:FRQ:SCALE_UPPER ±dd.dddE±d"
```

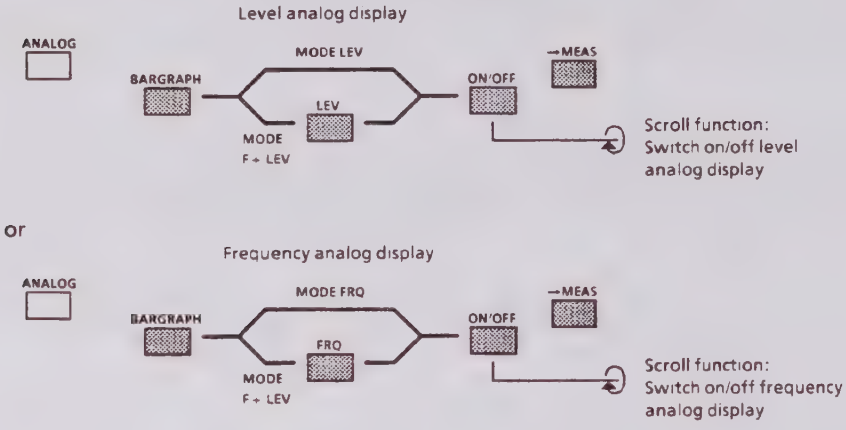
No specification of unit!
Unit refers to the current display unit of the measured value

LOWER: Lower full-scale value
UPPER: Upper full-scale value

### 3.4.9.4 Switching On/Off Analog Display

If level readout with analog display has been selected and a switchover is made to pure frequency display, the level analog display also changes to frequency analog display (and vice versa).

**Manual operation:**




The analog displays can be switched on or off individually. If an analog display is cut in via ON, the type of analog display that was cut in before is selected (VOL, AUTO or SCALE).

**IEC-bus operation:**

```
IEC OUT 20,"ANALOG:BARGRAPH:LEV:OFF"
           "ANALOG:BARGRAPH:FRQ:OFF"
```

In IEC-bus operation, the analog displays are cut in by means of "AUTO", "VOLUME", "SCALE_LOWER" or "SCALE_UPPER" and switched off by means of "OFF".

### 3.4.10 Extreme-value Display

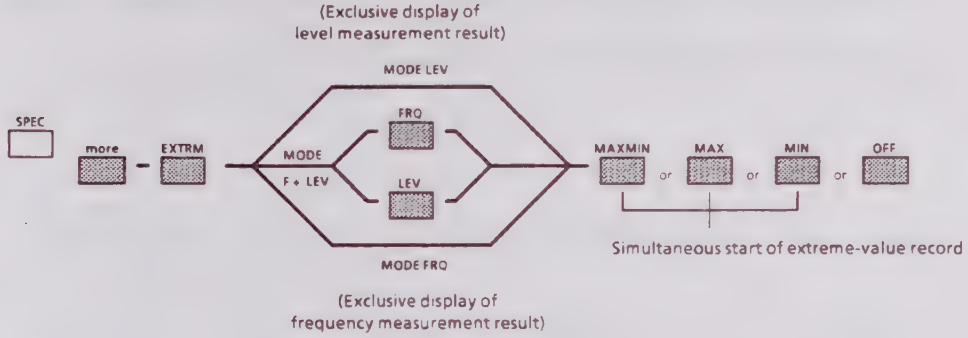
From the moment the extreme-value display is enabled, it displays

- the greatest measured value (MAX),
- the smallest measured value (MIN), or their
- difference (MAX-MIN).

The extreme-value display can be enabled either for the level display *or* for the frequency display (combination is not possible in the display mode F + LEV) and refers to the selected absolute or relative display unit.

***Each MODE-, DETECTOR-, UNIT ABS or UNIT REL change as well as the keystroke →MEAS starts a new record of the extreme value!***

**Manual operation:**




Readout on the display:

In the display mode F + LEV, it is not obvious whether the message displayed refers to frequency or level measurement!

**IEC-bus operation:**

```
IECOUT 20,"MODE:EXTREME:LEV:MAXMIN"
          "MODE:EXTREME:LEV:MAX"
          "MODE:EXTREME:LEV:MIN"
          "MODE:EXTREME:LEV:OFF"
          "MODE:EXTREME:FRQ:MAXMIN"
          "MODE:EXTREME:FRQ:MAX"
          "MODE:EXTREME:FRQ:MIN"
          "MODE:EXTREME:FRQ:OFF"
```

Simultaneous start of the extreme-value display

Activation of the extreme-value display of the level switches off the extreme-value display of the frequency.

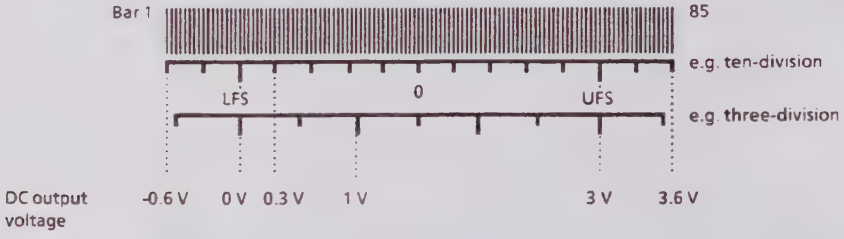
If pure display of level measurement result is selected and an attempt is made to activate the extreme-value display of the frequency, the command is without effect and an error message is produced → 3.5.10.3.
(Also vice versa!)

### 3.4.11 Analog Outputs DC1LEV and DC2FRQ (included in In/Out Option URE3-B2)

The rear outputs DC1LEV and DC2FRQ provide a DC voltage between -0.6 V and 3.6 V which is proportional to the level or frequency measurement result, e.g. for addressing a recording device.

The output level of the DC outputs is directly connected with the analog indication on the display the volume of which determines the output voltage of the DC output used.

The lower full-scale value corresponds to a DC output voltage of 0 V,
the upper full-scale value corresponds to a DC output voltage of 3 V,
irrespective of the scale (three- or ten-division) displayed:




After the DC outputs have been enabled (see below), their activation depends on the selection of the display → 3.2.3.1:

- only level display: DC1LEV active
- only frequency display: DC2FRQ active
- combined frequency/level display: DC2FRQ active and DC1LEV active

***The DC outputs are activated even with the bar switched off!***

Calculation of the DC output voltage depending on the displayed value and the scale:

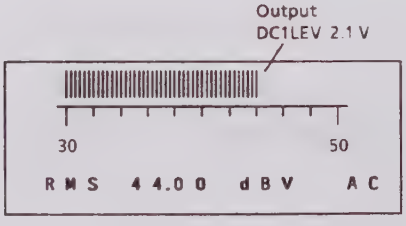
$$DC\ output\ voltage\ (V) = 3\ V \times \frac{DV - LFS}{UFS - LFS}$$

DV: Display value
LFS: Lower full-scale value
UFS: Upper full-scale value

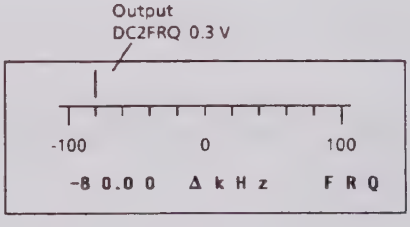
The DC output voltage is read out with a resolution of 1 mV.

*Examples:*

Analog level display reads 44.00 dBV
DC1LEV output voltage = 2.1 V




Analog frequency display reads -80.00 ΔkHz
DC2FRQ output voltage = 0.3 V



**Manual operation:**

**IEC-bus operation:**

```
IECOUT 20,"ANALOG:DCOUT:ON"
          "ANALOG:DCOUT:OFF"
```

## 3.4.12 External Trigger Input (Included in In/Out Option URE3-B2)

The external trigger input permits individual measurement results to be triggered upon external events such as e.g. occurrence of pulses in an electronic circuit. At the same time, the readout on the display is maintained until the next trigger event occurs.

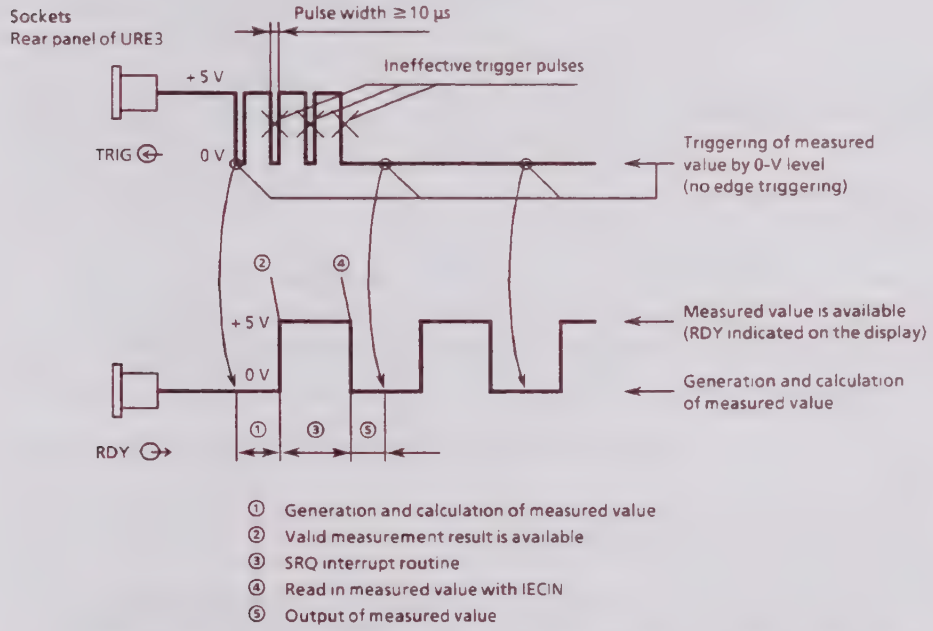



Fig. 3-8 Timing diagram external trigger input signal TRIG with Ready output signal RDY in the case of IEC-bus control

If the trigger pulses occur at a higher rate than measured values can be provided, the trigger pulses occurring in the time period between the beginning of the measurement and the output of the measured value remain ineffective, i.e. only after output of the measured value is a new trigger pulse accepted. If 0 V (GND) is constantly applied to the external trigger input, the instrument operates at the maximum possible measurement rate referred to the current setting.

Due to the negative logic, the trigger input signal can be generated by means of open collector circuits or bounce-free pushbuttons that connect the trigger input to ground.

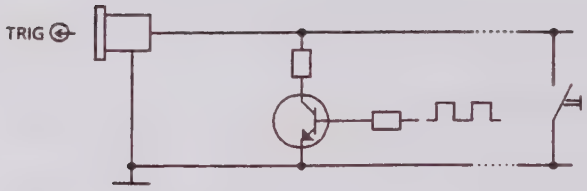
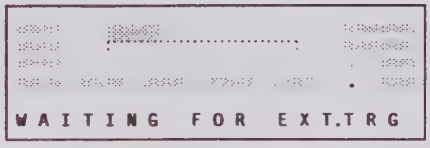



Fig. 3-9 Open-collector or bounce-free pushbutton circuit

**Manual operation:**

Enable (ON) or disable (OFF) external trigger input

Readout on the display:




Wait for external trigger

When enabled (ON), the external trigger input TRIG at the rear of the instrument permits individual measurement results to be triggered and read out on the display depending on an external trigger signal (→ Fig. 3-8).

A further measurement is started with the next 0-V level at the external trigger input only after the measurement result has been read out on the display.

***With external trigger enabled, each pressing of the →MEAS key causes a measured value to be triggered, as if an individual measurement result had been triggered via the external trigger input.***

**IEC-bus operation:**

```
IECOUT 20,"TRIGGER:EXTERN:ON"     Enable external trigger
IECOUT 20,"TRIGGER:EXTERN:OFF"    Disable external trigger
```

Even in IEC-bus operation, a measurement result can be triggered by an external trigger signal (→ Fig. 3-8) that has been enabled by means of "TRIG:EXT:ON". The response to an external trigger in IEC-bus operation corresponds exactly to the response to a GET command (→ 3.5.4.2.7).

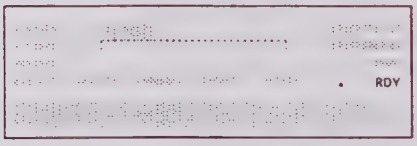
When a measurement result is available, this is indicated via SRQ with the MAV bit 6 of the status byte register (→ 3.5.10.1). Only after reading in the measurement result e.g. with IECIN 20, M$ is a further measurement started with the next 0-V level at the external trigger input.

*Program example with R&S Controller PSA:*

```
10 REM ***************************************************************
20 REM          Program for testing the external trigger
30 REM ***************************************************************
40 IEC TERM 1: REM Controller only responds to the terminator EOI
50 MZ=0: REM Reset counter for number of measurement results
60 BR=0: REM Reset break flag for program abort
70 INPUT "Enter number of desired measurement results: ";MX
80 IEC TIME 1000
90 IEC OUT 20,"*CLS"
100 IEC OUT 20,"*SRE 255"
110 IEC OUT 20,"TRIGGER:EXT:OFF": REM Disable ext. trigger
120 ON SRQ1 GOSUB 210: REM Enable SRQ interrupt routine
130 IEC OUT 20,"DISPLAY:ON"
140 IEC OUT 20,"TRIGGER:EXT:ON"
150 REM ---------------------------------------------------------
160 REM | Wait for SRQ with set MAV bit in endless loop! |
170 IF BR=0 THEN GOTO 170 ELSE END
180 REM ---------------------------------------------------------
190 REM
200 REM
210 REM --------- SRQ interrupt routine ---------
220 IEC SPL 20,SR%: REM Read in status byte
230 IF SR%=0 THEN GOTO 330
240 REM Measured value is available if MSS = 1, ESB = 0, MAV = 1 (50h = 80d)
250 IF SR%<>80 THEN GOTO 290: REM SRQ indicates error
260 REM --- Read in measurement results and output ---
270 IEC IN 20,M$: PRINT M$: MZ=MZ+1: IF MZ<MX THEN GOTO 340
280 IEC OUT 20,"TRIGGER:EXT:OFF": BR=1: GOTO 340
290 REM --- SRQ Error handling ---
300 PRINT "Status register: ";SR%
310 IEC OUT 20,"  *ESR?": IEC IN 20,ES$: PRINT "Event status register: ";ES$
320 IEC OUT 20,"ERRORS?": IEC IN 20,ER$: PRINT "Error register: ";ER$
330 IEC OUT 20,"TRIGGER:EXT:OFF"
340 ON SRQ1 GOSUB 210: RETURN
```

## 3.4.13 Measurement Result Ready Output (Included in In/Out Option URE3-B2)

Readout on the display when a valid measurement result is available:




The RDY output on the rear panel is set to logic 1 ( + 5 V) when a valid measurement result is available to be output on the display or via IEC bus. At the same time, the message RDY is read out on the display.

The RDY output signal is set to logic 0 (0V) and the RDY message on the display is erased when

- a measurement result has been read out via IEC bus by means of the IECIN command or
- a new measurement has been initiated or
- a key entry has been made or
- a setting has been performed via IEC bus.

→ Fig. 3-8

## 3.5 Remote Control

The instrument is equipped as standard with an IEC-bus interface. The interface complies with the standard IEC 625-1/IEEE 488.1 as well as with the standard IEC 625-2/IEEE 488.2. The standard IEC 625-2 includes the description of data transfer formats and common commands.

### 3.5.1 IEC-bus Control with the R&S Controllers of the PSA and PCA Family

All program examples listed in the operating instructions refer to the IBM-compatible R&S Controller of the PSA family (PSA5: Order No. 1006.3008.04) or of the PCA family in combination with the R&S BASIC program and its IEC-bus driver (installed as standard). All examples use the listener or talker address 20 which is the factory setting of the URE 3.

### 3.5.2 Particular Features of IEC-bus Control with the R&S Controllers PUC and PPC

***The following mnemonic code partly includes the ASCII character '_' in order to provide a clear structure (underscore = 5Fh = 95d = 137o). Users of the R&S Controllers PUC and PPC generate this ASCII character code by using the left arrow. The following BASIC program can be used to change the format of the response to the IEC-bus command "ERRORS:HARDWARE?", for example, such as to suit the format used by the PUC and PPC. The response is output with 63 characters a line, whereas the screen of the PUC and PPC displays only 40 characters a line:***

```
10 IEC TERM 0: REM Terminator CR + LF
20 DIM A$(10)
30 IEC OUT 20,"ERRORS:HARDWARE?"
40 IEC TAD 20
50 FOR I=1 TO 9:IEC $IN A$(I):NEXT
60 L=LEN(A$(2))
70 FOR I=2 TO 9 STEP 3
80 PRINT LEFT$(A$(I),L-31)
90 PRINT LEFT$(A$(I+1),L-31):PRINT
100 PRINT RIGHT$(A$(I),31)
110 B=29:IF I=8 THEN B=30
120 PRINT RIGHT$(A$(I+1),B):PRINT
130 NEXT
140 END
```

***When working with the PUC and PPC, the IEC-bus command IECTERM 1 causes the end of a data transfer to be marked by EOI, CR + LF. Operating according to the IEC-bus standard IEC-625.2, the instrument does not accept CR + LF after EOI and responds by sending an error message.***

***Remedy: Using ";" at the end of the command IECOUT, e.g.*** `IECOUT 20, "DETECTOR RMS";` ***causes CR + LF to be suppressed.***

***The command IEC%IN must not be used!***

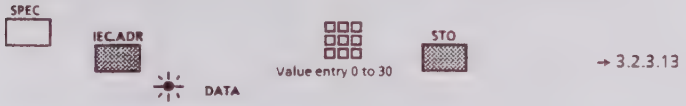
### 3.5.3 Preparation for IEC-bus Operation

#### 3.5.3.1 IEC-bus Connection

For connecting the Controller and the URE3, a shielded IEC-bus cable (e.g. 1 m long: R&S stock number 0292.2013.15) should be used in order to ensure minimum RF leakage and high immunity to interference.

### 3.5.3.2 Setting the IEC-bus Address

The IEC-bus address can be set from 0 to 30 via menu operation:




The IEC-bus address set remains stored in a non-volatile memory in the instrument. The IEC-bus address is factory-set to 20.

### 3.5.3.3 IEC-bus Interface

**Characteristics of the interface:**

The URE3 can be remote-controlled by an external controller via the IEC-bus interface.

- Data bus 8-bit parallel
- Bidirectional data transfer
- Three-wire handshake
- High data transfer rate max. 350 kbyte/s
- Up to 15 devices can be connected to the IEC-bus
- Total length of connection cable up to 15 m (single connection up to 2 m)

**Pin assignment and signal designations:**

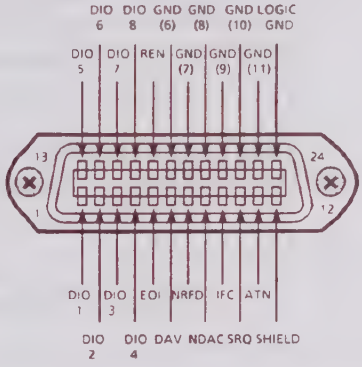



Fig. 3-10 Pin assignment of IEC bus

The IEC-bus interface is a 24-contact Amphenol connector the pin assignment of which is shown in Fig. 3-10 and Table 3-1.

The IEC bus consists of three groups of lines: the data bus (8 lines), the handshake bus (3 lines: DAV, NRFD, NDAC) and the management bus (5 lines: ATN, EOI, IFC, REN, SRQ).

Negative logic is used for the lines, i.e. the messages are true ( = 1) in the LOW state and false ( = 0) in the HIGH state. As the handshake and management lines are designed with an open-collector output, parallel connection of several devices via the bus results in a wired OR connection of the signals.

Table 3-1 Pin assignment according to IEC625/1 (IEEE488-1)

| Pin | Signal | Meaning | |
|---|---|---|---|
| 1 | DIO1(LSB) | Data bus, bidirectional | ┐ |
| 2 | DIO2 | Transfer line for data, addresses and commands | │ |
| 3 | DIO3 | Data transfer is bit-parallel and byte-serial via the characters in ISO 7-bit code (ASCII code). | │ |
| 4 | DIO4 | | Data bus |
| 13 | DIO5 | | │ |
| 14 | DIO6 | | │ |
| 15 | DIO7 | | │ |
| 16 | DIO8(MSB) | | ┘ |

| Pin | Signal | Meaning | |
|---|---|---|---|
| 6 | DAV | "Data valid"<br>Talker indicates with DAV = L that the data applied to the data bus are valid. | Handshake bus |
| 7 | NRFD | "Not ready for data"<br>Listener indicates with NRFD = L that no data can be accepted at the moment. | |
| 8 | NDAC | "Not data accepted"<br>Listener indicates with NDAC = L that the data have not been accepted yet. | |
| 5 | EOI | "End or identify"<br>As a function of ATN, this signal has two meanings with respect to the signals applied to the data bus:<br>ATN EOI Meaning on DIO<br>0 0 Data byte<br>1 0 Address or command<br>0 1 END (last data byte of a block)<br>1 1 IDENTIFY (request to identify following a service request) | Control bus |
| 9 | IFC | "Interface Clear"<br>With IFC = L, the system controller resets the remote-control lines of all connected devices to a basic state (pulse length approx. 100 µs) | |
| 10 | SRQ | "Service request"<br>This line enables each device equipped with this function to request service from the controller (SRQ = L). | |
| 11 | ATN | "Attention"<br>The controller sets ATN = L while addresses or commands are being transmitted via the data bus.<br>With ATN = H, data are being transferred. | |
| 17 | REN | "Remote enable"<br>With REN = L, the controller switches all connected devices to remote control, manual operation being disabled. | |
| 12<br>18,<br>19<br>20,<br>21<br>22,<br>23<br>24 | Shield<br>GND<br>GND<br>GND<br>GND<br>GND<br>GND<br>Logic GND | | |

### 3.5.3.4 IEC-bus Interface Function

Complying with the standard IEC 625-1, all instruments with IEC-bus capability can be equipped with various interface functions. Table 3-2 lists the interface functions implemented in the URE3:

Table 3-2 Interface functions

| Control character | Interface function |
|---|---|
| SH1 | Source handshake function, complete capability |
| AH1 | Acceptor handshake function, complete capability |
| L4 | Listener function, complete capability, unaddressing if MTA |
| T6 | Talker function, complete capability, capability to answer to serial poll, unaddressing if MLA |
| SR1 | Service Request, complete capability |
| PP1 | Parallel Poll function, complete capability |
| RL1 | Remote/local switchover function, complete capability |
| DC1 | Device Clear, complete capability |
| DT1 | Device Trigger, complete capability |

### 3.5.4 Universal Commands

Sections 3.5.4.1 and 3.5.4.2 list the most important universal commands necessary for system control. Further universal commands can be obtained from the manual of the controller used.

#### 3.5.4.1 Unaddressed Universal Commands

##### 3.5.4.1.1 Device Clear [DCL]

The DCL command sets all devices connected to the bus to a basic status. It should be used each time before using the bus anew and at the beginning of a program.

*Example with R&S Controller PSA:*

```
IECDCL
```

***According to the IEC-bus standard IEC-625.2, the DCL command does not cause a device-specific basic setting. A device-specific basic setting can be obtained using the common command "RST". (→ 3.5.5.2.2).***

##### 3.5.4.1.2 Local Lockout [LLO]

By inhibiting the LOCAL key, the LLO command prevents all devices on the bus from being manually operated (→ 3.2.3.14). The purpose of the LLO command is to avoid incorrect manual operation during IEC-bus control. Local lockout is indicated by the message LLO on the display.

*Example with R&S Controller PSA:*

```
IECLLO
```

Local lockout can be reset as follows:

- temporarily until the next addressing as listener:
  *Example with R&S Controller PSA:*
  ```
  IECLAD 20      → 3.5.4.2.1
  IECGTL         → 3.5.4.2.4
  ```
- definitely (for all devices connected to the bus):
  *Example with R&S Controller PSA:*
  ```
  IECNREN
  IECREN
  ```

##### 3.5.4.1.3 Read in Parallel Poll Status Byte [PPL]

After execution of the PPL instruction, all devices prepared to participate in the parallel poll with IEC PCON send their parallel poll status byte.

Detailed explanation: → 3.5.9.3 SRQ Evaluation with Parallel Poll

### 3.5.4.2 Addressed Universal Commands

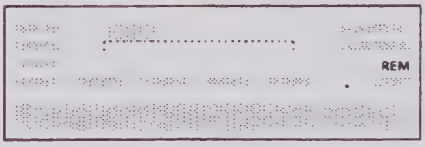
#### 3.5.4.2.1 Send Listener Address [LAD]

Device is addressed as listener.
Controller is connected to the device via IEC bus.
Addressed commands and data can then be received via IEC bus.

*Example with R&S Controller PSA:*

```
IECLAD 20
IECGET
```

Readout on the display:




REMote is also displayed in the case of all IEC-bus commands with integrated addressing, e.g. in the case of the R&S computer-specific commands IECPCON, IECOUT

#### 3.5.4.2.2 Send Talker Address [TAD]

Device is addressed as talker. Data can then be fetched via the bus.
Contributes to increasing the measurement rate in combination with the GET (group execute trigger) command (→ 3.5.4.2.7).

*Example with R&S Controller PSA:*

```
IECLAD 20
IECGET
IECTAD 20
IEC$IN M$
```

#### 3.5.4.2.3 Selected Device Clear [SDC]

Like the DCL command, the SDC command aborts each IEC-bus action not terminated in the device addressed as listener and sets the device to a defined basic status with respect to the IEC-bus interface.

It should be used each time before using the bus anew and at the beginning of a program.

*Example with R&S Controller PSA:*

```
IECLAD 20      → 3.5.4.2.1
IECSDC
```

***According to the IEC-bus standard IEC-625.2, the SDC command does not lead to a device-specific basic setting. A device-specific setting can be obtained using the common command "RST" (→ 3.5.5.2.2).***

### 3.5.4.2.4 Go To Local [GTL]

The GTL command enables all addressed devices to be manually operated again. When the instrument is in the calibration mode, the GTL command causes the measurement mode to be selected again. This command is effective until the device is again addressed as listener.

Inhibition of the LOCAL key by the LLO command (→ 3.5.4.1.2) is temporarily cancelled until the next addressing as listener. However, the LLO message remains on the display, as the inhibition of the LOCAL key is still effective when the device is addressed as listener again.

*Example with R&S Controller PSA:*

```
IECLAD 20     → 3.5.4.2.1
IECGTL
```

### 3.5.4.2.5 Output of Commands (ASCII String)

Using the IECOUT command, an IEC-bus device is addressed as listener and an ASCII string (e.g. common commands or device-specific commands) is output via IEC bus.

*Example with R&S Controller PSA:*

```
IECOUT 20,"RANGE:AUTO"
or
A$ = "MODE:DISP:LEV":
IECOUT 20,A$
```

### 3.5.4.2.6 Read in Measurement Result or Response to Query (ASCII String)

Using the IECIN command, an IEC-bus device is addressed as talker in order to read in an ASCII string from the IEC-bus output buffer of the device (measurement results or responses to queries) via IEC bus.

*Example with R&S Controller PSA:*

```
IECLAD 20: IECGET: REM Trigger measurement result
IECIN 20,MW$:      REM Read in measurement result
```

If the IECIN command is issued although the output buffer is empty, i.e. no trigger or query has preceded, an SRQ is generated and QYE bit 2 (query error) → 3.5.10.2 set in the event status register.

The instrument responds by sending a blank character string consisting of <NL>(0Ah) with EOI. Reading out the empty output buffer does *not*, as with some other instruments, result in a timeout error of the controller due to a data transfer that has not been accomplished. Even if the SRQ is not interrogated or is disabled, the blank character string and thus the empty output buffer can be easily identified as such in the further string processing.

If filing of a character string in the IEC-bus output buffer has caused an SRQ with the bit MAV set in the status byte register (MAV = Message AVailable → 3.5.10.1), the IECIN command will clear the SRQ status and the SRQ message on the display is extinguished.

### 3.5.4.2.7 Group Execute Trigger [GET]

The GET command causes a measurement result to be triggered in the addressed device. The GET command is particularly suited to obtain high measurement rates. It provides the measurement result in the output buffer from where it can be immediately transferred into a string variable by means of the INPUT command.

*Example with R&S Controller PSA:*

```
100 IECLAD 20
110 IECGET:       REM Trigger and file measurement result in the output buffer
120 IECIN 20, M$: REM Read in measurement result
130 PRINT M$:     REM Display measurement result on the screen
```

→ 3.5.11

### 3.5.4.2.8 Preparation for Parallel Poll

Preparation of a device for parallel poll → 3.5.9.3.

*Example with R&S Controller PSA:*

```
IEC PCON 20, 1, 6
```

- `6` — The SRQ status is signalled on the IEC-bus data line DIO6.
- `1` — The SRQ status is signalled with a 1 on the IEC-bus data line.
- `20` — The device with listener address 20 is prepared for a parallel poll.

The instruction `IECPCON 20, 1, 6` replaces the individual instructions

```
IECLAD 20
IECPPC
IECPPE 1, 6
IECUNL
```

Detailed explanation: → 3.5.9.3 SRQ Evaluation with Parallel Poll

Reading in the parallel poll status byte: → 3.5.4.1.3 Read in Parallel Poll Status Byte (PPL)

#### 3.5.4.2.9 Serial Poll [SPL]

*Example with R&S Controller PSA for serial poll of devices:*

```
IEC SPL 20,SB%
```

The instruction `IECSPL 20,SB%` replaces the individual instructions

```
IEC SPE
IECTAD 20
IEC%IN SB%
IEC MTA
IEC SPD
```

***The SPL command clears the SRQ status and the SRQ message on the display is extinguished.***

Detailed explanation: → 3.5.9.2 SRQ Evaluation with Serial Poll

### 3.5.5 Common Commands

The IEC-bus standard IEC-625.2 specifies a series of commands to be understood by each instrument operating according to this standard.

#### 3.5.5.1 Command Structure

Common commands are always addressed commands. They are marked by a "*" followed by three letters and, in some cases, by a "?". The commands followed by a "?" (e.g. "IDN?") request a response in the form of an individual ASCII character or an ASCII string.

*Example with R&S Controller PSA 5:*

```
IECOUT 20, "*IDN?"
```

#### 3.5.5.2 Overview of Common Commands

The instrument responds to the following common commands:

##### 3.5.5.2.1 Identification Query

"*IDN?" Identification query

The instrument responds to this query with an identification string.

*Example with R&S Controller PSA 5:*

```
IECOUT 20,"*IDN?": IECIN20,A$: PRINT A$
```

Readout on the screen: `ROHDE & SCHWARZ, URE 3, Firmwarevers.: 2.1`

### 3.5.5.2.2 Reset Command

"*RST" Reset Command

This command sets the instrument to the basic status:

- Measurement mode activated
- Initialization of internal keyboard controller
- Initialization of LCD controller, clear all segments of the display and write anew.
- AC measurement (AC)
- Rms-responding measurement (RMS)
- Level display unit mV
- Autoranging
- Analog display for level volume
- Analog outputs DC1LEV and DC2FRQ switched off
- Lower cutoff frequency 100 Hz
- Complete bandwidth of 30 MHz not limited (LP OFF)
- Measurement speed 5 ( = approx. 3 measurements per second)
- Offset voltage suppression off
- Frequency response correction off
- Correction of level measurement result off
- Rear frequency input off
- Outer conductor of the BNC input socket is ***not*** connected to ground (earthed conductor). FLOAT LED is illuminated.
- Free-running measurement, external trigger input is disabled
- Readout of measurement result formatted with header in IEC-bus operation
- Frequency reference value = 1000 Hz
- Level reference value = 1 V
- Impedance value = 600 Ω
- Zero value for offset voltage suppression = 0 V
- Correction factor for level measurement result = 1.0 (no correction)
- MODE-MEMORY off (→ 3.4.1)
- Time interval for measurement speed SYNC or INTV = 1 s
- Lower full-scale value = 1, upper full-scale value = 5 for the analog display SCALE
- Display of extreme value off
- Settling time of measured value unlimited. A fully settled measurement result is available after a trigger command.
- Internal, cyclical calibration on
- Illumination of LCD dimmed.
- Readout of measurement result following triggering

The reset command does not change:

- the IEC-bus address (the address last set is always maintained)
- Memory areas of complete instrument setups

### 3.5.5.2.3 Status Commands

The content of several status registers provides information on operating states and causes of errors during IEC-bus operation → 3.5.10.1/2:

- Status byte register STB → 3.5.10.1
- Service request enable register SRE
- Event status register ESR → 3.5.10.2
- Event status enable register ESE
- Parallel poll enable register PRE
- Individual status IST

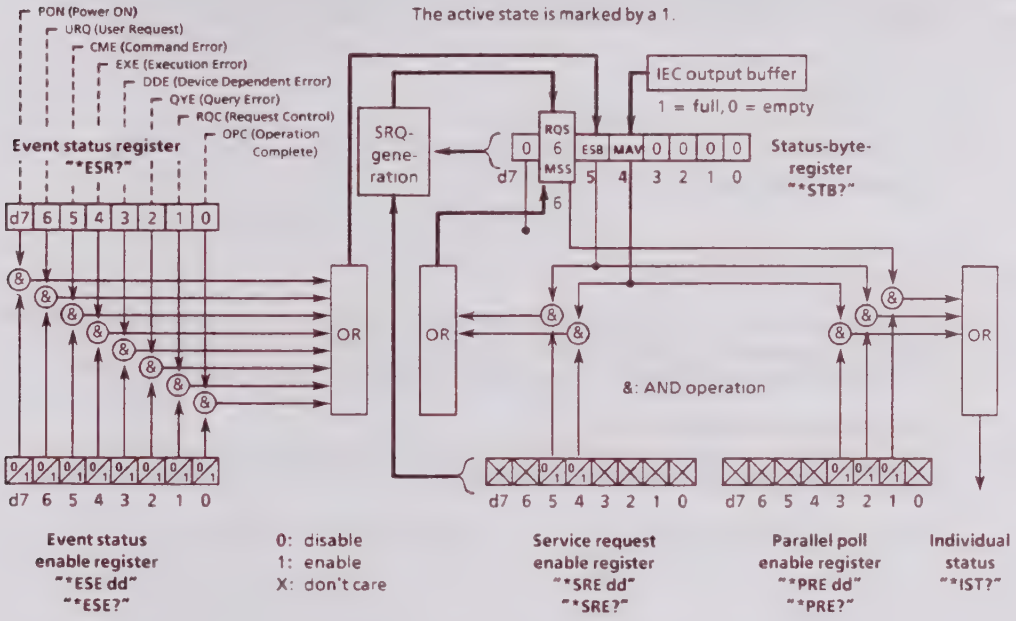



Fig. 3-11

The following commands permit the status registers to be

- viewed
- influenced
- masked.

"*CLS" **Clear Status Command**

The *CLS command clears the status byte register STB and the Request-for-OPC flag → 3.5.5.2.6, 3.5.12. If the *CLS command is followed by the terminator <NL> (0Ah) or EOI, the output buffer and the MAV bit are also cleared.

"*SRE ddd" **S**ervice **R**equest **E**nable Command

The *SRE command sets the service request enable register consisting of 8 bits and thus permits masking of the status byte register to determine whether particular errors or events are to lead to an error SRQ or not → Fig. 3-11.

ddd is an integral decimal value between 0 and 255 whose binary equivalent reveals the masking.

*Example with R&S Controller PSA:*

MAV Bit No. 4 (MAV = message available) and ESB bit No. 5 (ESB = Event Status Bit summary message) are to cause an SRQ. The corresponding bits No. 4 and No. 5 in the service request enable register are unmasked or set (1), all other bits are reset (0):

```
    ESB ┐  ┌ MAV
Bit  7 6 5 4 3 2 1 0
     0 0 1 1 0 0 0 0   = 0x30 (30h) = 48d
```

Thus the command reads: `IECOUT 20,"*SRE 48"`

"*SRE?" **S**ervice **R**equest **E**nable Query

This command permits to read out the current contents of the service request enable register. As a response, an ASCII string with an integral decimal value between 0 and 255 is transferred to the controller, the binary equivalent representing the current masking.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*SRE?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"239"`

"*STB?" **S**tatus **B**yte Query

This query permits the contents of the status byte register to be read out. As a response, an ASCII string with an integral decimal value between 0 and 255 is transferred to the controller, the binary equivalent providing some information on errors and events → 3.5.9, 3.5.10. By reading out the status byte register, the SRQ is not cleared, since the cause for the SRQ has been neither eliminated yet (a character string is present in the IEC-bus output buffer) nor interrogated by reading out the event status register (*ESR?).

*Example with R&S Controller PSA:*

```
IECOUT 20,"*STB?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"96"`

"*ESE ddd" **E**vent **S**tatus **E**nable Command

The *ESE command sets the event status enable register consisting of 8 bits and thus permits masking of the event status register to determine whether particular errors or events, each represented by one bit, are to lead to an error SRQ or not → Fig. 3-11.

ddd is an integral decimal value between 0 and 255 whose binary equivalent reveals the masking.

*Example with R&S Controller PSA:*

Bit No. 3 (device-dependent error) in the event status register constantly releases an SRQ; it is, however, subordinate to the current operation. All other events are still to release an SRQ. The corresponding bit No. 3 in the event status enable register is masked or reset (0), all other bits are set (1):

```
                ┌ DDE
Bit  7 6 5 4 3 2 1 0
     1 1 1 1 0 1 1 1  = 0xF7 (0F7h) = 247d
```

Thus the command reads: `IECOUT 20,"*ESE 247"`

"*ESE?" **E**vent **S**tatus **E**nable Query

This command permits the current contents of the event status enable register to be read out.

As a response, an ASCII string with an integral decimal value between 0 and 255 is transferred to the controller, the binary equivalent revealing the current masking.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*ESE?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"247"`

"*ESR?" **E**vent **S**tatus **R**egister Query

This query permits the programmer to read out the contents of the event status register. Reading out causes the register to be cleared.

As a response, an ASCII string with an integral decimal value between 0 and 255 is transferred to the controller, the binary value providing information on errors and events.

The ESR command clears the SRQ status; the SRQ message on the display is extinguished.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*ESR?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"32"`

"*PRE ddd" **P**arallel Poll Enable **R**egister **E**nable Command

***This command must not be confused with the addressed command IECPCON (→ 2.6.4.2.8) or PPL (→3.5.4.1.3)!***

It sets the parallel poll enable register consisting of 8 bits and thus permits masking of the status byte register in order to determine the status bit combinations to produce the answer "true" = ASCII"1" in the "*IST?" query → Fig. 3-11.

ddd is an integral decimal value between 0 and 255 the binary equivalent of which reveals the masking.

*Example with R&S Controller PSA:*

Only the MSS bit 6 and the ESB bit 5 of the status byte are to produce "true" in a "*IST?" query (→ Fig. 3-11).

These two bits are set in the parallel poll enable register:

```
            ESB ┐  ┌ MSS
Bit  7 6 5 4 3 2 1 0
     0 0 0 0 0 1 1 0 = 0x06 (006h) = 6d
```

Thus the command reads: `IECOUT 20,"*PRE 6"`

"*PRE?" **P**arallel Poll Enable **R**egister **E**nable Query

This command permits the current contents of the parallel poll enable register to be read out.

As a response, an ASCII string with an integral decimal value between 0 and 255 is transferred to the controller, the binary equivalent revealing the current masking.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*PRE?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"96"`

"*IST?" **I**ndividual **St**atus Query

permits evaluation of the status byte according to individual criteria and is performed by masking using the command "*PRE ddd".

To determine the occurrence of a particular status bit combination, the query "*IST?" is used. If the masked status bit combination occurs, the instrument responds by means of an ASCII "1", otherwise by means of "0".

"*PSC d" **Power-On Status Clear Command**

sets the power-on status clear flag:

d = 0: SRQ is output upon power-on. The power-on bit 7 (PON) is set in the event status register. The registers listed below are not affected.

d = 1: The following registers are reset upon power-on:
- Service request enable register ("*SRE 0")
- Event status enable register ("*ESE 0")
- Parallel poll enable register ("*PRE 0")

An SRQ is not released upon power-on.

*Example of presetting with R&S Controller PSA for SRQ output after switching on a device on the bus:*

```
10 IEC TERM 1
20 IEC OUT 20,"*PSC 0":   REM Output SRQ because of Power On
30 IEC OUT 20,"*SRE 96":  REM Enable ESB bit in status byte
40 IEC OUT 20,"*ESE 128": REM Enable only power-on bit 7 (PON) ...
                          REM ... in event status register
```

"*PSC?" **Power-On Status Clear Query**

This command permits to read out the current state of the power-on status-clear flag set by the command "*PSC d".

As a response, an ASCII "0" or "1" is transferred to the controller.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*PSC?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: "0"

"*CAL?" Operating mode query

Permits to read out the current operating mode:

| | | |
|---|---|---|
| Response ASCII "0": | Operating mode MEASURE | ("CALIBRATION:OFF") |
| Response ASCII "1": | Operating mode CALIBRATION | ("CALIBRATION:ON") |

*Example with R&S Controller PSA:*

```
IECOUT 20,"*CAL?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: "0"

### 3.5.5.2.4 Storing and Recalling Complete Setups

"*SAV dd" **Sav**e Command

Store complete setup at location dd (1 to 50) in the non-volatile memory

*Example with R&S Controller PSA:*

```
IECOUT 20,"*SAV 5"
```

"*RCL dd" **Rec**all Command

Recall complete setup from location dd (0 to 50)

***Location 0 stores the basic setting → 3.5.5.2.2.***

*Example with R&S Controller PSA:*

```
IECOUT 20,"*RCL 5"
```

### 3.5.5.2.5 Trigger Command

"*TRG" **Trig**ger Command

This command triggers a measurement.

*Example with R&S Controller PSA:*

```
IECOUT 20,"*TRG":       REM Trigger measurement
IECOUT 20,"RESULT?":    REM Request measurement result
IECIN 20,M$: PRINT M$: REM Read in measurement result and output
```

Readout on the screen: `"FRQ:HZ_ -067.13E+03;  ACDC:RMS:dBV_ -0001.00E+00"`

### 3.5.5.2.6 Synchronization Commands

"*OPC" **Operation Complete** Command

This command is used to synchronize several devices connected to the bus and the controller. It also causes the instrument to set bit 0 (OPC) in the event status register to 1 at the end of a measurement and thus request an SRQ.
Examples → 3.5.12

"*OPC?" **Operation Complete** Query

This command is used to synchronize the instrument with the controller.

a) **Triggering of measurement result (e.g. "*TRG") prior to command "*OPC?":**
After the command "*OPC?" has been issued, the parser waits for a feedback from the measurement task, i.e. further execution of commands by the parser is interrupted until this feedback has arrived. Then command execution by the parser is continued.
Examples → 3.5.12.

b) ***No* triggering of measurement result prior to the command "*OPC?"**
The parser interrupts the execution of commands when the command "*OPC?" is issued. An ASCII "1" is written in the output buffer, the MAV bit 4 is set in the status register and an SRQ is thus requested. Subsequently, command execution by the parser is continued. Examples → 3.5.12

***The "*OPC?" command does not affect the OPC bit in the event status register.***

"*WAI" **Wai**t-to-Continue Command

This command is used to synchronize the instrument with the controller.

a) **Triggering of measurement result (e.g. "*TRG") prior to the command "*WAI":**
After the command "*WAI" has been issued, the parser waits for a feedback from the measurement task, i.e. further execution of commands is interrupted until this feedback has arrived. Subsequently, command execution by the parser is continued.
Examples → 3.5.12.

b) ***No* triggering of measurement result prior to the command "*WAI":**
The command "*WAI" is ineffective!

### 3.5.6 Device-specific Commands

In cases where the function of the individual commands has already been made clear in the brief operating instructions (→ 3.2.3) and function descriptions (→ 3.4), the following description of commands only gives a short reference to the respective section of the manual.

All commands followed by a "?" request a response in the form of an ASCII string to be read in e.g. using the BASIC command: `IECIN 20,A$`

#### 3.5.6.1 Command Structure and Terminators

The commands can be written in upper-case or lower-case notation!

- Single command:
  `IECOUT 20,"XTR?"` or `"xtr?"`
- Single command with numerical data transfer:
  `IECOUT 20,"*SRE 32"`
- Compound command:
  `IECOUT 20,"DETECTOR:RMS` or `"Detector:RMS"`
- Compound command with numerical data transfer:
  `IECOUT 20,"REFERENCE:LEV:V 12.345E-3"` or `"Reference:Lev:V 12.345 mV"`

***Terminator: The instrument responds to command strings terminated by <NL> (0Ah or 10 d). <CR> (0Dh or 13d) ahead of <NL> is ignored.***

##### 3.5.6.1.1 Numerical Data

Numerical data are separated from the command by a space and can be specified as follows:

| | |
|---|---|
| Integral: | `IECOUT 20,"*ESE 96"` |
| Floating point: | `IECOUT 20,"REFERENCE:LEV:dBm -6.03"` |
| Floating point with exponent: | `IECOUT 20,"REFERENCE:FRQ 1000.0E+6"` |

To permit the permissible format of the numerical data to be precisely represented in the description of the individual commands, the following type of representation has been selected:

*Example of maximum format of numerical data:*

`"REFERENCE:LEV:V ±dd.dddE±d` (d represents digit)

*Example of short forms of numerical data:*

```
"REFERENCE:LEV:dBV ±dd.ddd"
"REFERENCE:IMP dd.dddE±d"
"*SRE dd"
```

### 3.5.6.1.2 Specification of Unit for Numerical Data

Units may be specified for part of the numerical data. → 3.5.6.2 Overview of Commands

```
IECOUT 20,"REFERENCE:FRQ 50.0kHz"      (optionally also in Hz or MHz)
```

If the value is indicated in its basic unit, the unit may be omitted after the value.

### 3.5.6.1.3 Abbreviation of Command Elements

Single commands (one command each IEC-bus output string) and units can be abbreviated until they only just differ from each other in the last letter (Upper-case letters in the overview of commands → 3.5.6.2).

*Example with R&S Controller PSA:*

```
IECOUT 20,"REFERENCE:LEV:W 47.0MW" → "REF:L:W 47.0M"
```

***Within an IEC-bus output string, the unambiguity of command elements must be ensured. Therefore, the short form for single commands cannot always be used when joining commands together (→ 3.5.6.1.4) or abbreviating compound commands (→ 3.5.6.1.5).***

***Example:***

```
"RANGE:FIX;FILTER:SPEED:FAST"   ⇒ COMMAND ACCEPT
"RA:F;F:S:F"                    ⇒ CHAR. MISPLACED
    └┘└──────  Not cleary distinguishable
"RA:FIX;FIL:S:F"
    └──┘└────  Cleary distinguishable
```

### 3.5.6.1.4 Queries

All commands including a data entry (→ Command overviews 3.5.5.2, 3.5.6.2) can be complemented with "?" and transmitted to the instrument which responds with an ASCII string representing the current data.

*Example with R&S Controller PSA:*

```
IECOUT 20,"REFERENCE:LEV?"
IECIN 20,A$: PRINT A$
```

Readout on the screen: `"REFERENCE:LEV:DBV -12.34E+00"`

### 3.5.6.1.5 Abbreviation of Compound Commands

Compound commands have a common header (e.g. "MODE..") followed by ":" and further single commands. The header need be written only once!

*Example with R&S Controller PSA:*

The following individual commands can be abbreviated as follows:

```
IECOUT 20,"MODE:FUNCTION:AC"
IECOUT 20,"MODE:DISP:FRQLEV"
IECOUT 20,"MODE:FRQIN:REAR"
IECOUT 20,"MODE:INPUT:GND"
```

```
IECOUT 20,"MODE:FUNCTION:AC;DISP:FRQLEV;FRQIN REAR;INPUT GND"
```

(";" = Separator)

### 3.5.6.1.6 Joining Together Different Commands

Different commands are joined together by means of ";".

*Example with R&S Controller PSA:*

The single commands can be output as a command sequence:

```
IECOUT 20,"MODE:DISP:LEV"
IECOUT 20,"DETECTOR:RMS"
IECOUT 20,"DISPLAY:ON"
IECOUT 20,"UNIT:LEV:dBV"
```

```
IECOUT 20,"MODE:DISP:LEV:DETECTOR:RMS;DISPLAY:VALUE:ON;UNIT:LEV:dBV"
```

(";" = Separator)

A command sequence must *not* contain several queries!

A query can be combined with other commands if it is the last one in the command sequence.

*Example with R&S Controller PSA:*

```
IECOUT 20,"MODE:FUNCTION:ACDC;DETECTOR:PEAK_PEAK;XTR?"
IECIN 20,A$: PRINT A$
```

### 3.5.6.2 Overview of Device-specific Commands

The short form for single commands (one command each IEC-bus output string) is marked by upper-case notation:
The shortest form of "Mode:FUnction:AC" thus reads "M:FU:AC"
(→ Important note in section 3.5.6.1.3)

| Analog display | |
|---|---|
| "Analog:Bargraph:Lev:Auto" | Scale of level analog display adapts to any measurement result. → 3.4.9.1 |
| "Analog:Bargraph:Lev:Volume" | Analog display for level volume → 3.4.9.2 |
| "Analog:Bargraph:Lev:SCALE_Lower ±d.dddE±d" | Freely selectable lower full-scale value → 3.4.9.3 |
| "Analog:Bargraph:Lev:SCALE_Upper ±d.dddE±d" | Freely selectable upper full-scale value → 3.4.9.3 |
| "Analog:Bargraph:Lev:Off" | Switch off level analog display → 3.4.9.4 |
| Query semantics | |
| "Analog:Bargraph:Lev:SCALE_Lower?"<br>"Analog:Bargraph:Lev:SCALE_Upper?" | Recall lower full-scale level value (non-dimensional)<br>Recall upper full-scale level value (non-dimensional)<br><br>Readout on the screen e.g.:<br>ANALOG:BARGRAPH:LEV:SCALE_UPPER 12.345E+00 |
| "Analog:Bargraph:Frq:Auto" | Scale of frequency analog display adapts to any measurement result. → 3.4.9.1 |
| "Analog:Bargraph:Frq:SCALE_Lower ±d.dddE±d" | Freely selectable lower full-scale value → 3.4.9.3 |
| "Analog:Bargraph:Frq:SCALE_Upper ±d.dddE±d" | Freely selectable upper full-scale value → 3.4.9.3 |
| "Analog:Bargraph:Frq:Off" | Switch off frequency analog display → 3.4.9.3 |
| Query semantics | |
| "Analog:Bargraph:Frq:SCALE_Lower?"<br>"Analog:Bargraph:Frq:SCALE_Upper?" | Recall lower full-scale frequency value (non-dimensional)<br>Recall upper full-scale frequency value (non-dimensional)<br><br>Readout on the screen e.g.:<br>ANALOG:BARGRAPH:FRQ:SCALE_UPPER 12.345E+00 |

| DC outputs DC1LEV and DC2FRQ | |
|---|---|
| "Analog:Dcout:ON"<br>"Analog:Dcout:OFf" | Switch on/off DC outputs → 3.4.11 |

| Set mode of operation | |
|---|---|
| "CALIBration:ON" | Switch instrument to calibration mode<br>In this operating mode, the instrument understands all common commands, the command "ERRORS?" and all calibration commands (→ Appendix). |
| "CALIBration:OFf" | Switch instrument to measurement mode.<br><br>In this operating mode, the instrument understands all common commands, the command "ERRORS?" and all commands **not** beginning with "CALIBRATION...", except "CALIBRATION:ON"<br>Unintentional destruction of calibration data by a calibration command issued inadvertently is thus impossible (→ Appendix). |

| Switch on/off internal, cyclical calibration | |
|---|---|
| "CALIBration:Internal:ON"<br>"CALIBration:Internal:OFf" | Internal calibration on<br>Internal calibration off<br>This command is called from the MEASUREMENT mode and *no* previous switchover to CALIBRATION mode is required!<br>→ 3.5.13 |

| Frequency response correction | |
|---|---|
| "COrrection:Frqresponse:ON"<br>"COrrection:Frqresponse:OFf" | → 3.4.7.2 |

| Selection of correction factor for correction of level measurement result | |
|---|---|
| "COrrection:Attenuation ±dd.dddDB"<br>"COrrection:Attenuation:ON"<br>"COrrection:Attenuation:OFf" | alternative unit dB → 3.4.7.1<br>and switch on correction of measurement result |
| ..... Query semantics ..... | |
| "COrrection:Attenuation?" | Recall level correction factor in dB<br><br>Readout on screen:<br>CORRECTION:ATTENUATION -12.345E+00 |

The display corrects positive dB values for an attenuator and negative dB values for an amplifier at the input socket.

| Offset voltage suppression | |
|---|---|
| "COrrection:Zero:Execute"<br>"COrrection:Zero:ON"<br>"COrrection:Zero:OFf" | Use current level measurement result as offset value and switch in offset voltage suppression → 3.4.4<br>Switch off offset voltage suppression → 3.4.4 |
| ..... Query semantics ..... | |
| "COrrection:Zero?" | Recall offset value<br><br>Readout on the screen:<br>CORRECTION:ZERO:DBUV -12.345E+00<br><br>The response string represents no valid IEC-bus command (and, therefore, must not be sent back to the instrument unchanged), but is to be regarded as a header for the offset value which reveals the unit of the offset value. |

| Select rectifier | |
|---|---|
| "DEtector:Rms" | Rms-responding rectifier → 3.4.1.1/2 |
| "DEtector:PEAK_POs" | Positive peak value → 3.4.1.3/4 |
| "DEtector:PEAK_Neg" | Negative peak value → 3.4.1.3/4 |
| "DEtector:PEAK_PEak" | Peak-to-peak value → 3.4.1.3/4 |

| Switch on/off settling time of measured value. | |
|---|---|
| "DELay:ON" | Unrestricted settling time of measured value. A fully settled measurement result is available after a trigger command. |
| "DELay:OFf" | Settling time of measured value switched off. If instruments which require settling times of signals to be programmed (generator, filter, etc.) are added via IEC bus in a test setup, the measurement sequence may be accelerated by omitting the settling time in the URE provided that the URE has already settled to a steady state.<br>***Saving of time approx. 7 ms.*** |

| Illumination | |
|---|---|
| "DIsplay:Illumination d" | Illumination of LCD can be varied in 7 steps:<br>d = 0: totally off<br>d = 1 to 5: 5 intermediate steps<br>d = 6: maximum brightness |

| Enable/suppress error message "DEVICE-Err." | |
|---|---|
| "DIsplay:Device_error:ON/OFf" | ON: If a device error occurs, the error message "DEVICE-Err.abcd" (→ 3.2.4) is not suppressed. Measured values are no longer displayed.<br><br>OFF: If a device error occurs, the error message "DEVICE-Err. abcd" can be suppressed instrument resumes the measurement although an error has been found. However, the error message is only suppressed when "Device-error:Off" has been output. If an error message with a different code occurs subsequently, this error message is displayed anew and measured values are no longer displayed |

| Display test | |
|---|---|
| "DIsplay:Test" | All display segments of the LCD are checked. Any subsequent IEC-bus command causes a normal display again. |

| Formatting of measurement result for output | |
|---|---|
| "DIsplay:Value:OFf" | Unformatted output of measurement result via IEC bus<br>Unformatted measurement results are always output with the shortest possible number of digits and are thus variable in length, but never have more than 13 digits.<br>Measurement result is ***not*** output on the display<br>This setting is to be preferred if maximum measurement rates are to be obtained.<br>*Example of unformatted measurement result via IEC bus:*<br>-99.E+03;-180. |
| "DIsplay:Value:ON" | Output of measurement result via IEC bus and display.<br>The individual measurement result is formatted (11 digits) and displayed<br>Formatted output of the measurement result takes approx. 13 ms longer for an individual output value than unformatted output of the result.<br>*Example of formatted measurement result via IEC bus:*<br>-099.99E+03;-0180.05E+00 |

| Interrogate cause of error | |
|---|---|
| Query semantics | |
| "Errors?" | After an SRQ has occurred, this command permits to determine the exact cause of the error by means of an error code. Reading out of the register causes it to be cleared. → 3.5.10 |
| "Errors:Lev_indication?" | Identification for level measurement result → 3.5.10.4 |
| "Errors:Frq_indication?" | Identification for frequency measurement result → 3.5.10.4 |
| "Errors:Device?" | Error in instrument → 3.5.10.4 |
| "Errors:Hardware?" | Hardware error in analog section → 3.5.10.4 |

| Filter settings | |
|---|---|
| "Filter:Hp 1000Hz"<br>"Filter:Hp 100Hz"<br>"Filter:Hp 10Hz" | Selection of lower cutoff frequency (highpass filter) → 3.4.2.2<br>alternative unit, optionally Hz or kHz |
| "Filter:Hp:Off" | Processing of measured value with DC coupling |
| | Selection of measurement speed → 3.4.2.1 |
| "Filter:Speed:SUperfast" | approx. 30 measurements/second ⎫ |
| "Filter:Speed:Fast" | approx. 3 measurements/second with AC/RMS |
| "Filter:Speed:SLow" | approx. 1 measurement/second ⎭ |
| "Filter:Speed:SYNC1" | RMS measurement: meas. time 1 s, search for signal periodicity |
| "Filter:Speed:INTV1" | PK measurement: period of observation 1 s |
| "Filter:Speed:SYNC10" | RMS measurement: meas time 10 s, search for signal periodicity |
| "Filter:Speed:INTV10" | PK measurement: period of observation 10 s |
| "Filter:Speed:SYNC ±dd.dddE±ds" | alternative unit, optionally s oder ms<br>RMS measurement: fixed optional measuring time<br>PK measurement: fixed optional period of observation |
| "Filter:Speed:INTV ±dd.dddE±ds" | alternative unit, optionally s or ms<br>RMS measurement: fixed optional measuring time<br>PK measurement: fixed optional period of observation |
| Query semantics | |
| "Filter:Speed:SYNC?" or<br>"Filter:Speed:INTV?" | Recall measuring or observation time in s<br>Readout on the screen e.g.: FILTER:SPEED:SYNC 1.2345E-00 |
| "Filter:Lp 20kHz"<br>"Filter:Lp 100kHz"<br>"Filter:Lp 1MHz" | Selection of upper cutoff frequency (lowpass filter) → 3.4.2.3<br>alternative unit, optionally Hz, kHz or MHz |
| "Filter:Lp Off"<br>"Filter:Lp:Off" | Switch off lowpass filter |

| Measurement result with/without header | |
|---|---|
| "Header:OFf" | *Example of readout without header:*<br>"-1.<NL>"<br>"-0001.00E+00<NL>"<br>" 99999.;1.<NL>"<br>"-099.99E+03;-0001.00E+00<NL>" |
| "Header:ON" | *Example of readout with header*<br>" ACDC:RMS:DBuV -180.<NL>"<br>"OR:ACDC:RMS:DBuV -0001.00E+00<NL>"<br>" FRQ:DHz -99999.;ACDC:RMS:dBuV -1.<NL>"<br>"QU:FRQ:DHz -099.99E+03;ACDC:RMS:dBuV -0001.00E+00;<NL>"<br>List of possible headers → 3.5.7.1.2 |

| Select measurement mode | | |
|---|---|---|
| "Mode:FUnction:AC" | AC measurement | → 3.4.1.1, 3.4.1.3, |
| "Mode:FUnction:Dc" | DC measurement | → 3.4.1.5 |
| "Mode:FUnction:ACDc" | AC + DC measurement | → 3.4.1.2, 3.4.1.4 |

| Select output of measurement result | |
|---|---|
| "Mode:Disp:Lev" | Display only level measurement result |
| "Mode:Disp:FRQ" | Display only frequency measurement result; nevertheless, a level measurement is always performed in the selected measurement mode. |
| "Mode:Disp:FRQLev" | Display level and frequency measurement result together. |

In conjunction with the commands "DISPLAY..." and "HEADER...", these commands are used for data output formatting with IEC-bus control → 3.5.7.1.2 Output of Measurement Result

| Select input socket for frequency measurement | |
|---|---|
| "Mode:FRqin:Rear" | Frequency measurement via rear BNC input socket (included in In/Out Option URE3-B2) → 3.4.1.6.2 |
| "Mode:FRqin:Front" | Frequency measurement via BNC input socket on the front panel → 3.4.1.6.1 |

| Select reference potential of outer conductor of BNC input socket | |
|---|---|
| "Mode:Input:Float" | Outer conductor of BNC input socket is **not** connected to ground (earthed conductor). FLOAT-LED on the front panel lights up. |
| "Mode:Input:Gnd" | Outer conductor of BNC input socket is connected to ground (earthed conductor) FLOAT-LED on the front panel does not light up.<br><br>***Important note:***<br>***Only reference potential! No safety connection according to VDE 0411!*** |

| Storing and recalling of instrument setups when changing MODE | |
|---|---|
| "Mode:Memory:ON" | With each MODE change (AC, DC, ACDC) or DETECTOR change (RMS, Peak), the current setting is internally stored in a non-volatile memory and the complete instrument setup of a corresponding previous setting is recalled → 3.4.1 |
| "Mode:Memory:OFf" | Instrument setup remains unchanged after changing the MODE or the DETECTOR → 3.4.1 |

| Extreme-value display for level and/or frequency measurement result | |
|---|---|
| "Mode:Extreme:Lev:MAX" | Maximum level value |
| "Mode:Extreme:Lev:MIN" | Minimum level value |
| "Mode:Extreme:Lev:MAXMIN" | Difference between maximum and minimum level value |
| "Mode:Extreme:Lev:OFF" | Switch off extreme level value display |
| "Mode:Extreme:Frq:MAX" | Maximum frequency value |
| "Mode:Extreme:Frq:MIN" | Minimum frequency value |
| "Mode:Extreme:Frq:MAXMIN" | Difference between maximum and minimum frequency value |
| "Mode:Extreme:Frq:OFF" | Switch off extreme frequency value display |

Activation of the function by means of MAX, MIN or MAXMIN simultaneously initiates storage of the extreme value.

| Measurement range settings | |
|---|---|
| "RAnge:Auto" | Autoranging with search for optimum measurement range |
| "RAnge:Auto 1mV...1000V" | Autoranging with presetting of measurement range |
| "RAnge:Hold" | Maintain the measurement range set as the lowest range; when the range is exceeded, change to higher measurement ranges. → 3.4.3.2 |
| "RAnge:Hold 1mV...1000V" | Maintain the measurement range specified as the lowest range; when the range is exceeded, change to higher measurement ranges. |
| "RAnge:Fix" | Maintain the measurement range set at any rate. → 3.4.3.3 |
| "RAnge:Fix 1mV...1000V" | Maintain the measurement range specified at any rate. |
| Query semantics | |
| "RAnge?" | Recall measurement range setting and measurement range<br>Readout on the screen e.g.: RANGE:HOLD 100mV |

The measurement ranges are specified in plain text; in detail, they read as follows:
1 mV, 3 mV, 10 mV, 30 mV, 100 mV, 300 mV, 1 V, 3 V, 10 V, 30 V, 100 V, 300 V, 1000 V
alternative unit, optionally V or mV. Messages indicating violation of the measurement range in IEC-bus operation → 3.4.3.4.

| Transfer level reference value | | |
|---|---|---|
| "REFerence:Lev:V ±dd.dddE±dV" | alternative unit, optionally kV, V or mV | → 3.4.5.1 |
| "REFerence:Lev:W ±dd.dddE±dW" | alternative unit, optionally kW, W, mW or uW (µW) | → 3.4.5.1 |
| "REFerence:Lev:DBV ±dd.dddDBV" | alternative unit, | → 3.4.5.1 |
| "REFerence:Lev:DBU ±dd.dddDBU" | alternative unit, | → 3.4.5.1 |
| "REFerence:Lev:DBUV ±dd.dddDBUV" | alternative unit, | → 3.4.5.1 |
| "REFerence:Lev:DBM ±dd.dddDBM" | alternative unit, | → 3.4.5.1 |
| Query semantics | | |
| "REFerence:Lev?" | Recall level reference value<br>Readout on the screen e.g.: REFERENCE:LEV:DBV -12.345E+00 | |

| Transfer frequency reference value | |
|---|---|
| "REFerence:Frq ±dd.dddE±dHz" | alternative unit, optionally Hz, kHz or MHz → 3.4.5.2 |
| Query semantics | |
| "REFerence:Frq?" | Recall frequency reference value in Hz<br>Readout on the screen e.g.: REFERENCE:FRQ -12.345E+00 |

| Transfer impedance value | |
|---|---|
| "REFerence:Imp ±dd.dddE±dOHM" | alternative unit, optionally kOHM → 3.4.5.3 |
| Query semantics | |
| "REFerence:Imp?" | Recall impedance value in Ω<br>Readout on the screen e.g.: REFERENCE:IMP 600.00E+00 |

| Request measurement result | |
|---|---|
| Query semantics | |
| "Result?" | Requests the measurement result triggered by the trigger command "*TRG".<br><br>*Example with R&S Controller PSA:*<br>IECOUT 20,"*TRG" :REM Trigger measurement<br>IECOUT 20,"RESULT?":REM Request measurement result<br>IECIN 20,M$: ?M$ :REM Read in measurement result and output<br>"1.2345E-03; 10.000E+06<NL>" |

| Enable/disable external trigger | |
|---|---|
| "Trigger:Extern:ON"<br>"Trigger:Extern:OFf" | Enable<br>Disable an external trigger signal via the BNC socket TRIG on the rear panel (included in In/Out Option URE3-B2).<br>Shape of trigger signal → Fig. 3-9<br>Example of application → 3.4.12 |

| Transfer display unit | | | |
|---|---|---|---|
| "Unit:Lev:V"<br>"Unit:Lev:DBU"<br>"Unit:Lev:DBV"<br>"Unit:Lev:DBM"<br>"Unit:Lev:W"<br>"Unit:Lev:DBUV" | Absolute level display units | V<br>dBU<br>dBV<br>dBm<br>W<br>dBµV | Conversion formulae → 3.4.6.1 |
| "Unit:Lev:DDb"<br>"Unit:Lev:DPCV"<br>"Unit:Lev:DV"<br>"Unit:Lev:V_Vr"<br>"Unit:Lev:P_Pr"<br>"Unit:Lev:DPCW"<br>"Unit:Lev:DW" | Relative level display units | ΔdB<br>%V<br>ΔV<br>V/Vr<br>P/Pr<br>%W<br>ΔW | Conversion formulae → 3.4.6.2 |
| "Unit:Frq:Hz"<br>"Unit:Frq:F_FR"<br>"Unit:Frq:DPchz"<br>"Unit:Frq:DHz" | Absolute frequency display unit<br>Relative frequency display units | Hz<br>F/Fr<br>%F<br>ΔHz | Conversion formulae → 3.4.6.4 |

| Triggering of measurement result | |
|---|---|
| Query semantics<br><br>"Xtr?" | Triggers a measurement and stores the result in the IEC-bus output buffer → 3.5.11<br>If this command is sent individually (i.e. not in a command sequence), the parser is dispensed with, enabling the second fastest triggering of the measurement result after the universal command GET |
| Query semantics<br><br>"XTRRef?" | Triggers a measurement, stores the measurement result as reference value and transfers the measurement result to the IEC-bus output buffer. → 3.5.11.1<br><br>*Example with R&S Controller PSA5.*<br>110 IECOUT 20,"XTRREF?": REM Store meas. result as ref. value<br>120 IECIN 20,M$: REM Clear output buffer<br>130 IECOUT 20,"UNIT:LEV:DDB": REM Select relative unit dB<br>140 IECOUT 20,"XTR?": REM Trigger again<br>150 IECIN 20,M$: PRINT M$: REM Output meas. result in rel. unit dB. |

### 3.5.6.3 Adaptation of IEC-bus Commands URE to URE2/3

| URE | URE2/3 |
|---|---|
| C1 | *RST |
| F0 | Filter:Speed:SLow;Hp 10Hz |
| F1 | Filter:Speed:Fast;Hp 100Hz |
| F2 | Filter:Speed:SUperfast |
| L0 | Filter:Lp:Off |
| L1 | not selectable |
| L2 | Filter:Lp 20kHz |
| L3 | Filter:Lp 100kHz |
| N0 | Header:ON |
| N1 | Header:OFf |
| U0 | Unit:Lev:V |
| U1 | Unit:Lev:DBV |
| U2 | Unit:Lev:DBM |
| U3 | Unit:Lev:DV |
| U4 | Unit:Lev:DPCV |
| U5 | Unit:Lev:DDb |
| U6 | Unit:Lev:V_Vr |
| V0 | DELay:ON |
| V1 | not available |
| V2 | DELay:OFf |
| V? | not available |
| RA Number | Mode:FUnction:AC;RAnge:Hold 1mV...300V |
| RD Number | Mode:FUnction:Dc;RAnge:Hold 1mV...300V |
| RC Number | Mode:FUnction:ACDc;RAnge:Hold 1mV...300V |
| DV Date | REFerence:Lev:V Data |
| DB Date | REFerence:Lev:DBV Data |
| DM Date | REFerence:Lev:DBM Data |
| DZ Date | REFerence:Imp Data |
| W0 | ┐ |
| W1 | ╵ |
| W2 | no longer permissible according to IEC standard 625-2 |
| W3 | ╵ |
| W4 | ┘ |
| W5 | fixed terminator (NL + EOI) |
| W6 | ┐ |
| W7 | no longer permissible according to IEC standard 625-2 |
| W8 | ┘ |
| Q0 | *SRE 0 |
| Q1 | *SRE 48;*ESE 255 |
| H1 | not available |
| X0 | not available |
| X1 | XTR? |
| X2 | XTRREF? |
| X3 | not available |
| X4 | not available |
| Z0 | REFerence:Lev? Unit with Unit:Ref? |
| Z1 | REFerence:Imp? |

Comparison of the IEC-bus commands used with the previous model RMS Voltmeter URE to those of the URE2/3.

Table for range numbers:

| URE | URE2/3 | | URE | URE2/3 | |
|---|---|---|---|---|---|
| 1 | 1 mV | only AC and AC + DC | 7 | 1 V | |
| 2 | 3 mV | only AC and AC + DC | 8 | 3 V | only AC and AC + DC |
| 3 | 10 mV | | 9 | 10 V | |
| 4 | 30 mV | only AC and AC + DC | 10 | 30 V | only AC and AC + DC |
| 5 | 100 mV | | 11 | 100 V | |
| 6 | 300 mV | only AC and AC + DC | 12 | 300 V | |

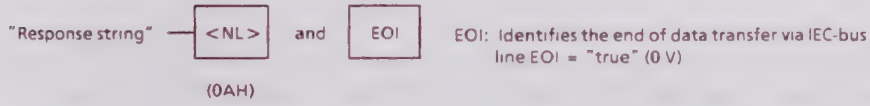
### 3.5.7 Data Output via IEC Bus

#### 3.5.7.1 Data Output to the Controller

The instrument responds to a request of measurement result or a query by transmitting an ASCII string to the controller where it is stored in a string variable (e.g. M$) and can be processed at will.

##### 3.5.7.1.1 Terminator of a Response String

According to the IEC-bus standard IEC-625.2, response strings transmitted from the measuring instrument to the controller must be terminated by the following terminator:




***If, in its basic setting, the controller used does n o t respond to <NL> or EOI but to a different terminator, transfer of a response string is not possible.***

***The controller must be set such as to respond to the respective terminator.***

**Setting the terminator on the controller:**

**Controller responds only to terminator EOI (IECTERM 1):**

The use of this setting is ***to be preferred*** as ***all*** response strings can be received without any problems!

**Controller responds only to terminator <NL> (IECTERM 10):**

This setting can be used for transferring the measurement result and for almost all responses to queries.

**Exception:**
The response to the queries "CALINFO_1?" "CALINFO_2?" "CALINFO_3?"
(→ Appendix) contains <CR> and <NL> for formatted display on the screen. The transfer would be aborted after the first <NL>. For the queries given above, the controller is to be set to respond to IECTERM 1!

### 3.5.7.1.2 Output of Measurement Result via IEC Bus

The display of the measurement result is determined by several settings:

**Selection of the measured quantity frequency:**
`IECOUT 20,"MODE:DISP:FRQ"`

**Selection of the measured quantity level:**
`IECOUT 20,"MODE:DISP:LEV"`

**Selection of the measured quantity frequency and level:**
`IECOUT 20,"MODE:DISP:FRQLEV"`

**Unformatted output:**
`IECOUT 20,"DISPLAY:OFF"`

Output of measurement result in undefined length without or with random exponent representation, e.g.
" 0." " 0.123" " 20." "-300." " 1000." " 2.345" "-1.234" "-8765.4" " 5.268E-09"
"-9.8765E + 09" " 9.8765E + 08" " 1.E-05" "-1.E-07" but never more than 13 digits.

**Formatted output:**
`IECOUT 20,"DISPLAY:ON"`

Output of measurement result via IEC bus and display. Result is read out with 11 digits using engineering exponent representation. *Example:* "099.99E + 03;-0180.05E + 00<NL>"

**With header:**
`IECOUT 20,"HEADER:ON"`

**Without header:**
`IECOUT 20,"HEADER:OFF"`

Output of measurement result after triggering, e.g.:
```
IECOUT 20,"XTR?"
IECIN 20,M$: PRINT M$
```

**Measured quantities frequency or level:**

| | | |
|---|---|---|
| unformatted | without header | "-1.<NL>" |
| unformatted | with header | "OR:ACDC:RMS:dBuV -180.<NL>" |
| formatted | without header | "-001.00E+00<NL>" |
| formatted | with header | "UR:ACDC:RMS:dBuV -001.00E+00<NL>" |

**Measured quantities frequency and level:**
Sequence of readout: "frequency measurement result; level measurement result"

| | | |
|---|---|---|
| unformatted | without header | "1.; 99999.<NL>" |
| unformatted | with header | "QU:FRQ:DHZ__ -9.9;UR:ACDC:RMS:DBUV -1.<NL>" |
| formatted | without header | "-099.99E+03;-001.00E+00<NL>" |
| formatted | with header | "QU:FRQ:DHZ__ -099.99E+03;UR:ACDC:RMS:DBUV -0001.0E+00<NL>" |

**List of possible headers**

```
___FRQ:HZ___  -dd.dddE+dd:___AC__:RMS:V___  -dd.dddE+dd
QU:     F_FR_             UR:DC__:PKP:DBV_
VO:     DHZ__             OR:ACDC:PKN:DBUV
NA:     DPCHZ             FO:     PP_:DBU_
                          VO:  ___:W___
                               DBM_
                               V_VR
                               P_PR
                               DDB_
                               DV__
                               DW__
                               DPCV
                               DPCW
```

Detailed character layout overleaf!

Meaning of abbreviations:

| | | | | | |
|---|---|---|---|---|---|
| FRQ | = Frequency | AC__ | = AC | V___ | = V |
| | | DC__ | = DC | DBV_ | = dBV |
| Hz__ | = Hz | ACDC | = AC + DC | DBUV | = dBµV |
| F_FR_ | = F/Fr | | | DBU | = dBu |
| DHZ__ | = ΔHz | RMS | = RMS | W___ | = W |
| DPCHZ | = %F | PKP | = + Peak | DBM_ | = dBm |
| | | PKN | = - Peak | V_VR | = V/Vr |
| ___ | = Error-free measurement result | PP_ | = Peak to Peak | P_PR | = P/Pr |
| QU | = Questionable frequency measurement result | | | DDB_ | = ΔdB |
| VO | = Level/frequency measured (VOid) | | | DV__ | = ΔV |
| NA | = Output of frequency measurement result is not allowed (Not Available) | | | DW__ | = ΔW |
| | | | | DPCV | = %V |
| UR | = Measured value is below the range | | | DPCW | = %W |
| OR | = Range is exceeded | | | | |
| FO | = Range is exceeded with FIX range | | | | |

***If one of the abbreviations UR to NA has occurred, the origin can be exactly determined via the polls "ERROR:LEV_INDICATION" and "ERROR:FRQ_INDICATION?" (→ 3.5.10.4).***

**Measurement results that cannot be displayed:**

These measurement results are represented as characteristic values which, at first sight, differ from valid measurement results:

| Representation on the display | Error code in header | Value via IEC bus | Meaning |
|---|---|---|---|
| Last digit of value blinks | "UR" | valid | Measured value is below the range |
| Entire value blinks | "OR" | valid | Range is exceeded |
| OFLO | "___" | " 99999.E+99" | Computed value can no longer be displayed |
| UFLO | "___" | "-99999.E+99" | Computed value can no longer be displayed |
| FIXO | "FO" | " 99999 E+99" | Range is exceeded with FIX range |
| VOID | "VO" | " 88888.E+88" | Causes → 3.2.5 |
| Entire value blinks | "QU" | valid | Analog hardware overdriven. Questionable frequency measurement result |
| Last digit of value blinks | "QU" | valid | Analog hardware underflow. Questionable frequency measurement result |
| -NA- | "NA" | " 77777.E+77" | Frequency measurement result is not available. -NA- |

Messages caused by violations of the measurement range in IEC-bus operation → 3.4.3.4

" ␣␣␣FRQ:HZ_-_-_␣␣dd.ddd±dd:␣␣␣AC_-_-:RMS:V_-_-_␣␣dd.ddd±dd "

```
QU :       : F _ F R _
VO :       : D H Z _ _
NA :       : D P C H Z

UR : DC_ _ : P K P : D B V _
OR : ACDC  : P K N : D B U V
FO :       : P P _ : D B U _
VO :       : _ _ _ : W _ _ _
                   : D B M _
                   : V _ V R
                   : P _ P R
                   : D D B _
                   : D V _ _
                   : D W _ _
                   : D P C V
                   : D P C W
```

␣ : Blank (20h)

_ : Underscore (55Fh)

- : Blank for positive value, minus sign for negative value

#### 3.5.7.1.3 Responses to Queries

Responses to queries marked by "?" are to be obtained from the command overviews (→ 3.5.5.2, 3.5.6.2).

### 3.5.8 Programming the IEC Bus for the First Time

When operating the URE 3 via IEC bus for the first time, make sure that the IEC-bus address is set to 20 (→ 3.5.3.2). It is then possible to proceed according to the following examples without making any further changes.

*Example with R&S Controller PSA and its BASIC program:*

**Request the URE 3 identification string:**

| | |
|---|---|
| `IECTERM 1` | To enable the controller to receive a response string, it must be set to respond to the terminator EOI (→ 3.5.7.1.1). |
| `IECOUT 20,"*IDN?"` | Request the URE 3 identification string (→ 3.5.5.2.1). |
| `IECIN 20,A$` | Enter the response string into the string variable A$ |
| `PRINT A$` | Output the content of the string variable A$ on the screen |

The following string must be displayed on the screen:

`ROHDE & SCHWARZ, URE 3, Firmwarevers.: x.y` x.y = firmware version number

**Triggering of measurement result:**

| | |
|---|---|
| `IECTERM 1` | |
| `IECOUT 20,"*RST"` | Set the instrument to the switch-on status |
| `IECOUT 20,"XTR?"` | Trigger the measurement and store the measurement result in the output buffer |
| `IECIN 20,M$` | Enter the measurement result into the string variable M$ |
| `PRINT M$` | Output the content of the string variable M$ on the screen |

Depending on the input signal, a measurement result is displayed on the screen, e.g.

`"AC__:RMS:V___ 00.153E-03"`

### 3.5.9 Service Request (SRQ)

Setting of the IEC-bus line SRQ (Service Request) enables the instrument to request service from the controller.

This is useful when the end of a measurement, violation of the measurement range or the occurrence of an error is to be reported to the controller.

### 3.5.9.1 Prerequisites for SRQ

The controller used must be able to perform two tasks:

- When the SRQ line of the IEC bus goes to zero (active low), it must interrupt the running program, jump into a service routine and continue the program at the place of interruption after evaluating the SRQ.
- The controller must be able to identify the device sending the SRQ, since SRQ messages are sent by several devices on the very same SRQ line. For this purpose, the status byte register of the device that may be responsible for the SRQ is read out (→ 3.5.5, Fig. 3-11). By decoding the status byte, the cause of the SRQ can be determined (→ 3.5.10.1).

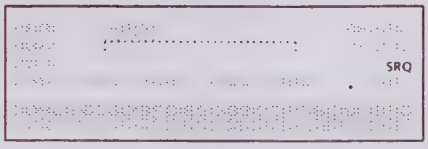
Interruption of a BASIC program as a result of an SRQ must be enabled by a BASIC command:

*Example with R&S Controller PSA:*

```
30 ON SRQ GOSUB 100
```

Line number points to beginning of SRQ interrupt routine

Readout on the display:




In the SRQ interrupt routine, the device on the bus that has issued the SRQ must be determined. For this purpose, two procedures are provided:

1. Serial Poll → 3.5.9.2
2. Parallel Poll → 3.5.9.3

### 3.5.9.2 SRQ Evaluation with Serial Poll

After an SRQ has occurred (SRQ read out on the display), the running BASIC main program is interrupted and, as a result of the command ON SRQ GOSUB 100, the SRQ interrupt routine beginning with line 100 is entered. In this routine, the device that might have caused the SRQ is addressed by the command e.g. `IEC SPL 20, SB%` and the status byte is read into an integer variable as 8-bit integer value.

If MSS bit 6 of the status byte in SB% is set (→ 3.5.10.1), e.g.

```
IF (SB% AND 64) <>0 THEN ...,
```

the device polled has sent the SRQ.

***The SPL command clears the SRQ status; the SRQ message on the display is extinguished.***

*Program example with R&S Controller PSA:*

```
10 IECTIME 1000
20 IECTERM 1:            REM Controller responds only to terminator EOI
30 ON SRQ GOSUB 100:     REM Initialization of SRQ program interrupt
40 IECOUT 20,"*SRE 255": REM Enable all SRQ causes
       :
       :
  Main program
       :
       :
100 REM *** Beginning of SRQ interrupt routine ***
110 IECSPL 20, SB%:           REM Poll device with address 20
120 IF (SB% AND 64) = 0 THEN GOTO 200: REM Poll next device
130 PRINT "Contents of status byte register = ";SB%
       :
       :
  Decode status byte
       :
       :
500 ON SRQ GOSUB 100: RETURN: REM Enable new SRQ, return to main program
510 REM *** End of SRQ interrupt routine ***
520 END
```

At the end of the SRQ interrupt routine, the command ON SRQ GOSUB 100 must again be issued to enable the BASIC program to respond to a new SRQ. For returning from the SRQ interrupt routine into the interrupted main program, the RETURN instruction is used.

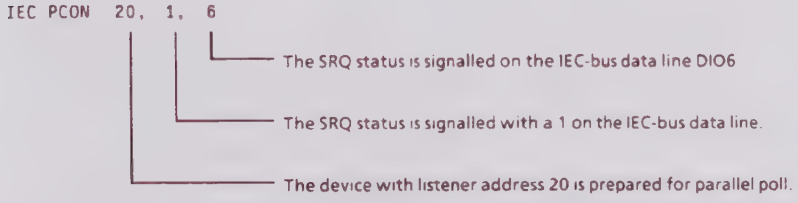
### 3.5.9.3 SRQ Evaluation with Parallel Poll

The parallel poll constitutes the second method of determining which of the devices connected to the bus has sent an SRQ. If several (max. 8) devices are connected to the bus, the parallel poll is to be preferred to the serial poll as it can be executed faster.

In order to determine the device sending the SRQ via a parallel poll in the SRQ interrupt routine, each device connected to the bus is assigned an IEC-bus data line (DIO8 to DIO1) at the beginning of the program on which it can respond when it is polled.

Devices not prepared for the parallel poll do not participate.

Preparation of a device for the parallel poll is accomplished by the R&S Controller PSA5 using the command:


IEC PCON 20, 1, 6
The SRQ status is signalled on the IEC-bus data line DIO6
The SRQ status is signalled with a 1 on the IEC-bus data line.
The device with listener address 20 is prepared for parallel poll.

In the following program example, the running BASIC main program is interrupted after an SRQ has occurred (SRQ message read out on the display) and the SRQ interrupt routine beginning with line 80 is entered as a result of the command ON SRQ GOSUB 80. In the interrupt routine, the command e.g. `IEC PPL PP%` is used to read the parallel poll status byte into the integer variable PP%.

Then it is possible to determine on which data line and thus from which device the SRQ has been sent.

Parallel poll status byte

| Bit | DIO8 7 | DIO7 6 | DIO6 5 | DIO5 4 | DIO4 3 | DIO3 2 | DIO2 1 | DIO1 0 |
|---|---|---|---|---|---|---|---|---|
| *Example:* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

DIO6 is set: 00100000 = 20h = 32d
Masking of the parallel poll status byte with 32 permits the IEC-bus line DIO6 to be polled.

*Program example with R&S Controller PSA:*

```
10 IECTERM 1: IECDCL:
20 IECOUT 20,"*CLS,*SRE 255,*PRE 255"
30 IECPCON 20,1,6: REM SRQ status for URE 3 is signalled on DIO6
40 IECPCON 10,1,3: REM SRQ status for another device is signalled on DIO3
50 ON SRQ GOSUB 80
       .
       .
       .
       Main program
       .
       .
       .
80 REM ************ SRQ interrupt routine *************
90 IECPPL PP%: REM Read in parallel poll status byte
100 IF (PP% AND 32) <> 0 THEN GOTO 200: URE 3 has sent the SRQ
110 IF (PP% AND  4) <> 0 THEN GOTO 300: Other device has sent the SRQ
120 REM
200 REM ------- SRQ evaluation for URE 3 --------
210 IECSPL 20,SB%
220 PRINT "Status byte register (STB) = ";SB%
230 IECOUT 20,"*ESR?"
240 IECIN 20,ES$: PRINT "Event status register (ESR) = ";ES$
250 IECOUT 20,"ERRORS?"
260 IECIN 20,ER$: PRINT "Error register = ";ER$
270 GOTO 500
280 REM
300 REM ------- SRQ evaluation for another device -------
310 IECSPL 10,S%
       .
       .
       .
500 ON SRQ GOSUB 80: RETURN
510 REM ******* End of SRQ interrupt routine *********
```

### 3.5.10 Error Handling via IEC Bus

If, during IEC-bus operation, errors are found by the parser when commands are output with the IECOUT command, an error message is read out in plain text on the display:

| Plain text and error messages on the display | Error number from error register → 3.5.10.3 |
|---|---|
| COMMAND ACCEPT | 0 (Error-free command in measurement mode) |
| CALIBRATION MODE | 0 (Error-free command in calibration mode) |
| NO VALUE DISPLAYED | 0 (Note indicating after the command "DISPLAY:OFF" that measurement results are no longer read out on the display Measurement result can then only be read via IEC bus!) |
| DEVICE-Err. = abcd | 64 (abcd → 3 5 10.3) |
| CHAR. MISPLACED | 130 |
| CHAR. ILLEGAL | 131 |
| COMMAND ILLEGAL | 132 |
| COMMAND UNCLEAR | 133 |
| VALUE OUT OF RANGE | 195 |
| UNIT ILLEGAL | 196 |
| UNIT UNCLEAR | 197 |
| COMMAND ERROR xxx | xxx: error number from error register → 3.5 10.3 |

If, as a result of an error, an SRQ has been enabled using the common commands "*SRE ddd" and "*ESE ddd", the error source can be determined via the following registers:

- Status byte register (→ 3.5.10.1)
- Event status register (→ 3.5.10.2)
- Error register (→ 3.5.10.3)
- Determine exact error source (→ 3.5.10.4)

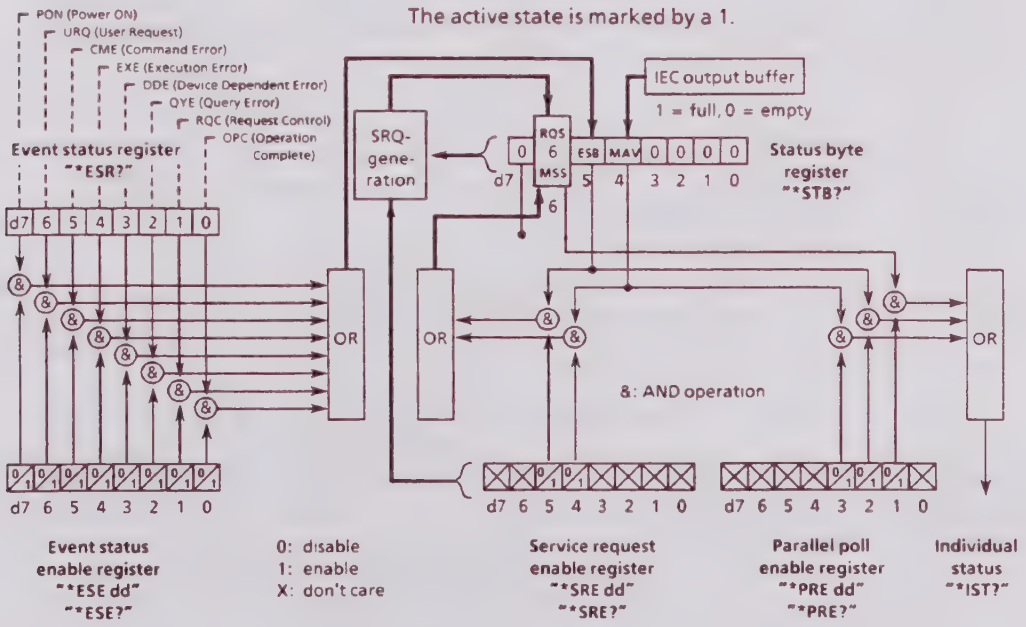
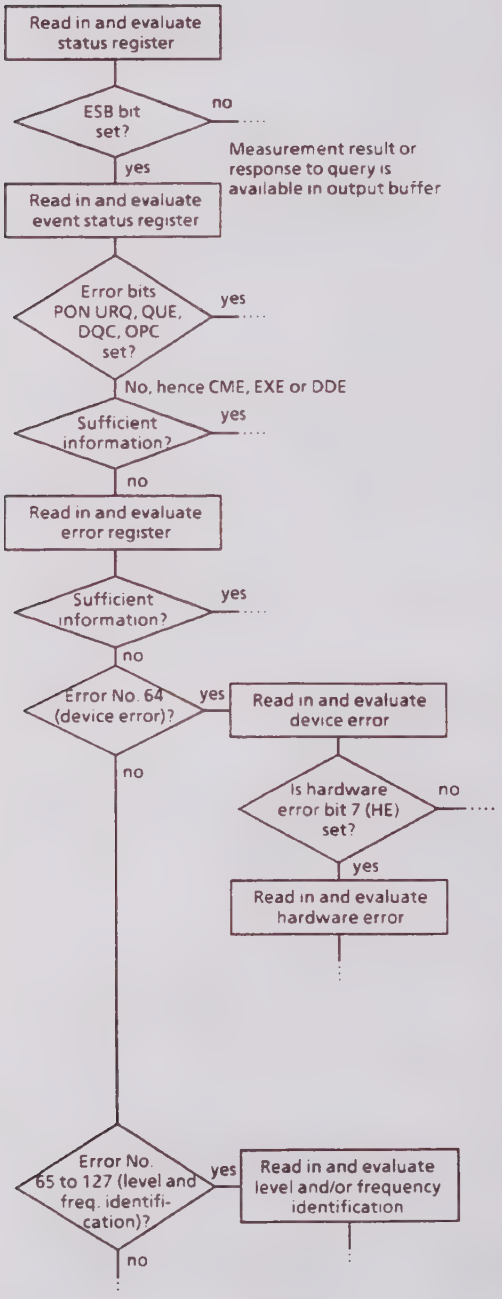

The active state is marked by a 1.
PON (Power On)
URQ (User Request)
CME (Command Error)
EXE (Execution Error)
DDE (Device Dependent Error)
QYE (Query Error)
RQC (Request Control)
OPC (Operation Complete)
Event status register "*ESR?"
d7 6 5 4 3 2 1 0
SRQ-gene-ration
IEC output buffer
1 = full, 0 = empty
RQS MSS
0 6 ESB MAV 0 0 0 0
d7 5 4 3 2 1 0
Status byte register "*STB?"
OR
&
&: AND operation
Event status enable register "*ESE dd" "*ESE?"
0: disable
1: enable
X: don't care
Service request enable register "*SRE dd" "*SRE?"
Parallel poll enable register "*PRE dd" "*PRE?"
Individual status "*IST?"

Fig. 3-11




| Example with R&S Contr. PSA | Comment |
|---|---|
| `IECOUT 20, "SRE 32"` | 32 = 00100000. Enable ESB bit of status byte register which signals error messages from the event status register. |
| `IECOUT 20, "ESE 8"` | 48 = 00001000. Enable the error messages device-dependent error (DDE) in the event status register. |
| `IECSPL 20, SB%`<br>`PRINT SB%`<br>`96` | Read in contents of status byte register and output.<br>96 = 01100000. RQS and ESB are set, i.e. SRQ has occurred and an error is signalled in the event status register. |
| `IECOUT 20, "*ESR?"`<br>`IECIN 20, ES$`<br>`PRINT ES%`<br>`8` | Request, read in and output contents of status event register.<br>8 = 00001000. Bit 3 (DDE) is set, indicating a device-dependent error. |
| `IECOUT 20, "ERRORS?"`<br>`IECIN 20, ES$`<br>`PRINT ES%`<br>`8` | Request, read in and output contents of status event register.<br>8 = 00001000. Bit 3 (DDE) is set, indicating a device-dependent error. |
| `IECOUT 20, "ERRORS:DEVICE"`<br>`IECIN 20, A$`<br>`PRINT A$` | Request, read in and output device error identification |

Readout on the screen:

```
"Hex value: 0015
--  --  --  --  --  --  --  CE  HE  --  TR  TS  --  BL  CF  CP *)
 0   0   0   0   0   0   0   0   0   0   0   1   0   1   0   1"
```

| | |
|---|---|
| `IECOUT 20, "ERRORS:HARDWARE?"`<br>`IECIN 20, A$`<br>`PRINT A$` | Request, read in and output hardware error. |

Readout on the screen:

```
"Hex value: 08AA
--HEADER--  ET  ---  ---  AA  EH  ZD  ZPD  ZPA  ZMD  ZMA  ZR  --*)
 0   0   0   0   1   0   0   0   0   1   0   1    0    1    0    1   0
Hex value: 4100
DZL  DZS  ---  ---  Z11  Z10  Z9  Z8  Z7  Z6  Z5  Z4  Z3  Z2  Z1  Z0*)
 0    1    0    0    1    0    1   0   0   0   0   0   0   0   0   0
Hex value: 0200
---  ---  ---  GPA  ---  GMA  GR  ---  ---  ---  ---  ---  ---  ---  ---  ---*)
 0    0    0    0    0    0    1   0    0    0    0    0    0    0    0    0"
```

| | |
|---|---|
| `IECOUT 20, "ERRORS:LEV_INDICATION?"`<br>`IECIN 20, A$`<br>`PRINT A$` | Request, read in and output level identification. |

Readout on the screen:

```
"Hex value: 1528
--HEADER--  R3  R2  R1  R0  EH  SY  OH  OM  OL  UM  UU  --*)
 0   0   0   1   0   1   0   1   0   0   1   0   1   0   1   1
```

*) Meaning of error bits →3.5.10.4.

### 3.5.10.1 Status Byte Register

MSS bit 6: (Master Summary Status message)

Is set if ANDing of all other bits of the status byte register and the corresponding bits of the service request enable register produce the result "true" at least once.

***Setting of this bit involves the generation of a service request (SRQ).***

ESB bit 5: (Event Status Bit summary message)

Is set if ANDing of the event status register with the event status enable register produces the result "true" at least once. An SRQ is released when the ESB bit has been enabled by the corresponding bit in the service request enable register. In order to determine the cause of the SRQ in greater detail, the event status register is to be polled (→ 3.5.5.2.3 *ESR?).

MAV bit 4: (Message AVailable)

Is set if the output buffer contains data (e.g. after a query or trigger). An SRQ is released when the MAV bit has been enabled by the corresponding bit in the service request enable register.

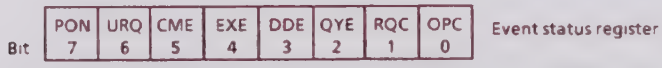
***Reading of the character string (→ 3.5.4.2.6) deletes the SRQ status - the SRQ display is extinguished!***

***Bits 0 to 3 and 7 of the status byte register are not busy and thus always 0!***

(→ Fig. 3-11)

### 3.5.10.2 Event Status Register

One bit is reserved for a particular event in the event status register. It is set to 1 upon occurrence of this event.




OPC bit 0: (OPeration Complete)

Is set when a command sequence terminated with *OPC is executed.

RQC bit 1: (ReQuest Control)

Is set when a device requests the control over the bus.

QYE bit 2: (QuerY Error)

Is set when

- the controller requests data to be output (e.g. IECIN 20,A$) although the output buffer is empty or when
- a data output cycle has been aborted, i.e. instead of fetching a string stored in the output buffer using an IECIN command, a different action has been performed (e.g. a setting command IECOUT 20,"...") → 3.5.10.3 Error Register.

DDE bit 3: (Device Dependent Error)

Is set when device-specific errors occur.
Exact determination of the source of error → 3.5.10.3 Error Register

EXE bit 4: (EXecution Error)

Is set when an actually permissible command cannot be executed (e.g. entered value is not within the permissible range).
Exact determination of the source of error → 3.5.10.3 Error Register

CME bit 5: (CoMmand Error)

Is set when the parser has detected an illegal command.
Exact determination of the source of error → 3.5.10.3 Error Register

URQ bit 6: (User ReQuest)

Is set when a key has been pressed on the instrument during IEC-bus operation.

PON bit 7: (Power ON)

Is set after switching on the instrument. → 3.5.5.2.3 "*PSCd"

Each of these bits is ANDed with the corresponding bit in the event status enable register. If the result of at least one of these operations is "true", bit 5 (ESB bit) is set in the status byte register. An SRQ is released when the ESB bit has been enabled by the corresponding bit in the service request enable register (→ Fig. 3-11).

### 3.5.10.3 Error Register

By reading out the event status register with the query "*ESR?" (→ Fig. 3-11), a rough overview of errors can be obtained.

For detailed decoding of the errors indicated in the event status register

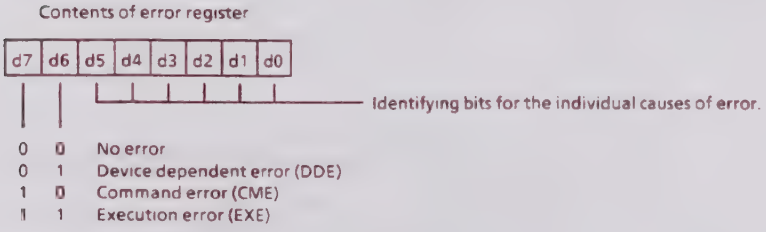
DDE = **D**evice **D**ependent Error (Bit 3)
EXE = **EX**ecution Error (Bit 4)
CME = **C**o**M**mand Error (Bit 5)

read out the error register using the command `"ERRORS?"`.

*Example with R&S Controller PSA:*

```
        :
        :
SRQ has occurred
        :
        :
IECOUT 20,"ERRORS?"
IECIN20,A$: PRINT A$
23
```

Immediately after the parser has detected an error, an error message is read out on the display in plain text which is directly connected with the error number in the error register (reference → 3.5.10). The error numbers are output in decimal format and are divided into the three categories DDE, CME and EXE:




Bits d6 and d7 indicate the rough error cause
Bits d0 to d5 give detailed information on the error cause.

| No. | Readout on the display | Description of error |
|---|---|---|
| 0 | COMMAND ACCEPT | Error-free command in measurement mode |
| 0 | CALIBRATION-MODE | Error-free command in calibration mode |
| 0 | NO VALUE DISPLAYED | Following the command "DISPLAY:VALUE:OFF", this message indicates that no more measurement results are output on the display<br>Measurement result can only be read via IEC bus. |

**DDE: Device dependent errors (Error numbers 64 to 127)**

| No. | Readout on the display | Description of error |
|---|---|---|
| 64 | DEVICE-Err. = abcd | Error in the device<br><br>**Decoding with the IEC-bus command**<br>"ERRORS:DEVICE?" → 3.5.10 4 Device error |
| 65 to 127 | | Provides information on the validity of the measured value<br>More detailed decoding using the IEC-bus commands<br>"ERRORS:LEV_INDICATION?"<br>"ERRORS:FRQ_INDICATION?" → 3.5.10.4 |

| | | Frequency measurement result | | | Level measurement result | | | |
|---|---|---|---|---|---|---|---|---|
| d7 | d6 | d5 | d4 | d3 | d2 | d1 | d0 | |
| 0 | 1 | | | | 0 | 0 | 0 | o.k. |
| 0 | 1 | | | | 0 | 0 | 1 | Value below the range |
| 0 | 1 | | | | 0 | 1 | 0 | Range exceeded |
| | | | | | 0 | 1 | 1 | Range exceeded with FIX range |
| | | | | | 1 | 0 | 0 | invalid |
| | | 0 | 0 | 0 | o.k. | | | |
| | | 0 | 0 | 1 | questionable (value below the range) | | | |
| | | 0 | 1 | 0 | questionable (value exceeds the range) | | | |
| | | 0 | 1 | 1 | does not occur | | | |
| | | 1 | 0 | 0 | frequency measurement result is available | | | |
| | | 1 | 0 | 1 | frequency measurement result not available | | | |

**CME: Command errors (Error numbers 129 to 133)**

| No. | Readout on the display | Description of error |
|---|---|---|
| 130 | CHAR. MISPLACED | The command string includes a character that is not permissible at this position. |
| 131 | CHAR. ILLEGAL | Impermissible character!<br>The following characters are permissible:<br>A to Z a to z 0 to 9 + * ? / : ; , <NL> # - _ |
| 132 | COMMAND ILLEGAL | Name of command is unknown or impermissible.<br><br>***Important:***<br>***This case may also arise when the specified command does not belong to the operating mode MEASUREMENT (CALIBRATION:OFF) or CALIBRATION (CALIBRATION:ON) (→ 3.5.6.2 Appendix A)*** |
| 133 | COMMAND UNCLEAR | Occurs when a command has been abbreviated to such a degree that the parser has found a second command with the same combination of initials |

| EXE: Execution errors (Error numbers 193 to 255) | | |
|---|---|---|
| **No.** | **Readout on the display** | **Description of error** |
| 195 | VALUE OUT OF RANGE | 1. Entered value is outside the permissible range.<br>2. The measured value triggered by the IEC-bus command "XTRREF?" is invalid and cannot be used as reference value. |
| 196 | UNIT ILLEGAL | Specified unit is illegal |
| 197 | UNIT UNCLEAR | Specified unit is unclear<br>Occurs when a unit has been abbreviated to such a degree that the parser has found a second unit with the same combination of initials |
| 199 | COMMAND ERROR 199 | 1. Controller requests data to be output (e g. IECIN 20;A$) although the output buffer is empty or<br>2 Instead of fetching a string provided in the output buffer with an IECIN command, a command has been issued with IECOUT |
| 200 | FATAL ERROR | Execution of the internal control program in the parser is disturbed on account of an error in the EPROM or RAM. |
| 201 | COMMAND ERROR 201 | Analog level display with pure frequency display or analog frequency display with pure level display is not permissible! |
| 203 | COMMAND ERROR 203 | HP OFF not permissible in measurement modes AC/PK, AC + DC/PK and DC |
| 204 | COMMAND ERROR 204 | I/O-Option URE3-B2 not installed! |
| 205 | COMMAND ERROR 205 | Detector setting RMS or PK is not permissible for measurement mode DC. |
| 206 | COMMAND ERROR 206 | Level measurement with extreme-value display when a pure frequency result is output or frequency measurement with extreme-value display when a pure level result is output is not permissible. |

### 3.5.10.4 Determination of Exact Cause of Error

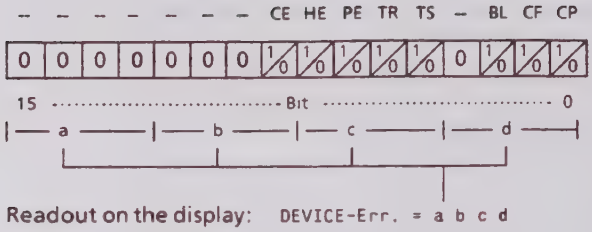
When the error number
64 (DEVICE-Err. = abcd, error in device) or
65 to 127 (identification of frequency and level measurement result)
has been determined via the error register, the IEC-bus queries ERRORS:...? can be used to call the lowest level of error detection in case the information of the error register is not yet sufficient. Thus the most detailed error decoding possible is obtained.

Bit is relevant for the evaluation and can assume the value 0 or 1.

Bit always has the value 0

Irrelevant for error evaluation, but can assume the value 0 or 1.

**Device error:**




Readout on the display: `DEVICE-Err. = a b c d`

*Example with R&S Controller PSA:*

```
IECTERM 1
IECOUT 22 "ERRORS:DEVICE?"
IECIN 20,A$: PRINT A$
```

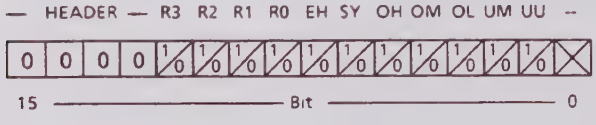
Readout on the display:

```
"Hex value: 0015
-- -- -- -- -- -- -- -- CE HE -- TR TS -- BL CF CP
0  0  0  0  0  0  0  0  0  0  0  1  0  1  0  1"
```

This error message represents exactly the code read out on the display with "DEVICE-Err. = abcd" due to the error number 64 of abcd = hexadecimal value representing 16 bits:

| | | |
|---|---|---|
| CP= 1 | Checksum error of EPROMs. | Device error |
| CF= 1 | Calibration data missing. | Device error |
| BL= 1 | Battery failed. | Device error |
| TS= 1 | Time exceeded when transmitting to analog board | Device error |
| TR= 1 | Time exceeded when receiving from analog board. | Device error |
| PE= 1 | Parity error during data transfer between analog board and main processor<br>**Call and decoding with the IEC-bus command explained below**<br>"ERRORS:HARDWARE?". | Device error |
| HE= 1 | Hardware error in analog section.<br>**Call and decoding with the IEC-bus command explained below**<br>"ERRORS:HARDWARE?". | Device error or input error |
| CE= 1 | Calibration error | Device error or input error |

**Identification of level measurement result:**



*Example with R&S Controller PSA:*

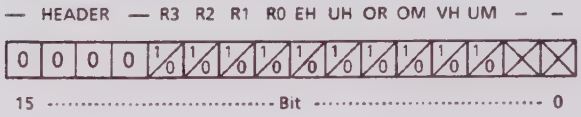
```
IECTERM 1
IECOUT 22 "ERRORS:LEV_INDICATION?"
IECIN 20,A$: PRINT A$
```

Readout on the screen:

```
"Hex value: 152B
- HEADER -  R3 R2 R1 R0 EH SY OH OM OL UM UU --
0  0  0  0  0  1  0  1  0  0  1  0  1  0  1  1"
```

| | | |
|---|---|---|
| R3 to R0 | Measurement range set | Conversion of binary code into **rated** measurement range value<br>0000 = 1 mV, 0001 = 3 mV, 0010 = 10 mV, 0011 = 30 mV<br>0100 = 100 mV, 0101 = 300 mV, 0110 = 1 V, 0111 = 3 V<br>1000 = 10 V, 1001 = 30 V, 1010 = 100 V, 1011 = 300 V<br>1100 = 1000 V<br>***The binary code must not be converted into the range number for calibration (→ Appendix A)!*** |
| EH = 1 | Hardware error | Hardware error in analog section.<br>**Call and decoding with the IEC-bus command explained below**<br>"ERRORS:HARDWARE?" |
| SY = 1 | Synchronous measurement | With measurement speed SYNC, the measurement could be performed synchronous with the test signal.<br>Display readout: "LOCKED"<br>The SY bit is irrelevant for all other measurement speeds. |
| OH = 1 | Hardware overflow | Hardware is overdriven, range cannot be changed as FIX range is set or AUTO range or RANGE HOLD are in the highest measurement range<br>Two conditions lead to OH:<br>1. A/D converter is overdriven<br>2 Range control has responded due to heavy overdrive<br>The measurement result is most probably false.<br>Indication on the display: "FIXO"<br>IEC-bus output: "F0:.... 99999.E + 99" |
| OM = 1 | Overflow of measured value | Similar to OH. Hardware is slightly overdriven, but measurement result is probably still correct. Two conditions lead to OM:<br>1. Range limits are exceeded with FIX range, AUTO range or RANGE HOLD in the highest measurement range.<br>2. Range control signals slight overdrive, e.g due to<br>• excessive crest factor,<br>• overdriven input amplifier when the lowpass filter is cut in,<br>• DC measurement with too large AC component.<br>In general, this does not happen with measurements triggered via IEC bus or with external trigger, since a less sensitive measurement range is automatically selected in this measurement mode unless the highest measurement range is already set.<br>Indication on the display: Entire measured value blinks<br>IEC-bus output: "OR:.... displayable value" |
| OL = 1 | Range overflow | The measurement range maintained with RANGE HOLD has been exceeded.<br>Indication on the display: Entire measured value blinks<br>IEC-bus output: "OR:.... displayable value" |
| UM = 1 | Underflow of measured value | Measured value was below the range with RANGE HOLD or FIX RANGE, the measurement accuracy is reduced.<br>Indication on the display: Last digit of measured value blinks<br>IEC-bus output: "UR:....displayable value " |
| UU = 1 | Unavoidable underflow | Occurs only with UM = 1 if, due to the ranging conditions, a more sensitive measurement range cannot be selected (range control).<br>• AC component with DC measurement too large.<br>• Range control has responded because crest factor was too large or signal components were suppressed by HP or LP cut in. |

**Identification of frequency measurement result**




*Example with R&S Controller PSA:*

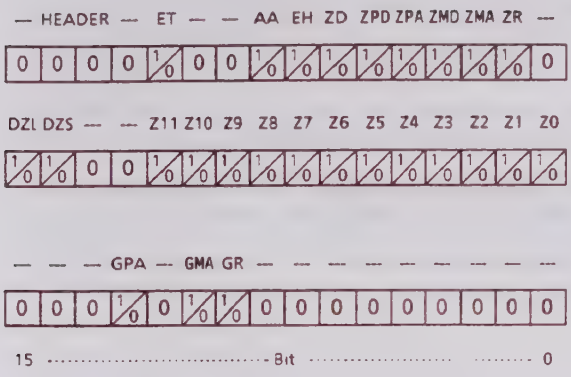
```
IECTERM 1
IECOUT 22 "ERRORS:FRQ_INDICATION?"
IECIN 20,A$: PRINT A$
```

Readout on the screen:

```
"Hex value: 60A9
- HEADER -  R3 R2 R1 R0 EH UH OR OM VH UM XX --
0  0  0  0  0  0  0  0  1  0  1  0  1  0  0  1"
```

| | | |
|---|---|---|
| R3 to R0 | Measurement range set | Conversion of binary code into **rated** measurement range value.<br>0000 = 1 mV, 0001 = 3 mV, 0010 = 10 mV, 0011 = 30 mV<br>0100 = 100 mV, 0101 = 300 mV, 0110 = 1 V, 0111 = 3 V<br>1000 = 10 V, 1001 = 30 V, 1010 = 100 V, 1011 = 300 V<br>1100 = 1000 V<br>***The binary code must not be converted into the range number for calibration (→ Appendix A)!*** |
| EH = 1 | Hardware error | Hardware error in analog section.<br>**Call and decoding with the IEC-bus command explained below**<br>"ERRORS:HARDWARE?" |
| UH = 1 | Measuring or reference counter has not counted | Measurement result is invalid.<br>Readout on the display: "VOID"<br>IEC-bus output: "V0:.... 88888.E + 88" |
| OR = 1 | Reference counter overflow | Measurement result is invalid.<br>Readout on the display: "VOID"<br>IEC-bus output: "V0:.... 88888.E + 88" |
| OM = 1 | Measuring counter overflow | Measurement result is invalid.<br>Readout on the display: "VOID"<br>IEC-bus output: "V0:.... 88888.E + 88" |
| VH = 1 | Analog hardware overdriven | Measurement result questionable.<br>Readout on the display: Entire measured value blinks.<br>IEC-bus output: "QU:.... displayable value" |
| UM = 1 | Analog hardware underflow | Measured result questionable<br>FRONT input selected and value is 10 dB below the threshold voltage with RMS or 20 dB with PK, or the test signal is unipolar with AC + DC/PK.<br>Readout on the display: Entire value blinks<br>IEC-bus output: "QU:.... valid value" |

**Hardware error in analog section:**




*Example with R&S Controller PSA:*

```
IECTERM 1
IECOUT 20,"ERRORS:HARDWARE?"
IECIN 20,A$: PRINT A$
```

Readout on the screen:

```
"Hex value: 08AA
--- HEADER ---  ET  --  --  AA  EH  ZD  ZPD ZPA ZMD ZMA ZR  --
0   0   0   0   1   0   0   0   1   0   1   0   1   0   1   0
Hex value: 4A00
DZL DZS --- --- Z11 Z10 Z9  Z8  Z7  Z6  Z5  Z4  Z3  Z2  Z1  Z0
0   1   0   0   1   0   1   0   0   0   0   0   0   0   0   0
Hex value: 0200
--- --- --- GPA --- GMA GR  --- --- --- --- --- --- --- --- ---
0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0
```

| | |
|---|---|
| ET | ET = 1: parity error with transmission from controller → analog board<br>ET = 0 and PE bit = 1 (see "ERRORS:DEVICE?"):<br>parity error with transmission from analog board → controller |
| AA = 1 | Adjustment input amplifier |
| EH = 1 | This bit is set if one of the error bits (except ET) is set (ORing of all error bits) |
| ZD = 1 | DC offset |
| ZPD = 1 | Offset + PK rectifier, DC coupling |
| ZPA = 1 | Offset + PK rectifier, AC coupling |
| ZMD = 1 | Offset -PK rectifier, DC coupling |
| ZMA = 1 | Offset -PK rectifier, AC coupling |
| ZR = 1 | OFFSET RMS rectifier |
| DZL = 1 | DC offset lowpass filter |
| DZS = 1 | DC offset measuring path AC slow |
| Z0 to Z11 | DC offset hardware measurement ranges 0 to 11 |
| GPA = 1 | Amplifier + PK rectifier, AC coupling |
| GMA = 1 | Amplifier -PK rectifier, AC coupling |
| GR = 1 | Amplifier RMS rectifier |

Meaning of identification letters:
A = AC, C = Control, D = DC or Delta, E = Error, G = Gain, L = Low Pass, M = -PK, P = +PK, R = Reference, S = Slow, T = Transmission, U = Voltage, Z = Zero

### 3.5.11 Triggering of Measurement Result via IEC Bus

In order to trigger a measured value via IEC bus three trigger commands are provided:

**Addressed universal command GET:**

The GET command starts a measurement and files the measurement result in the IEC-bus output buffer. It can be immediately read into a string variable using an input command.

GET permits to achieve the ***maximum measurement rate of 30 measurements per second*** by selecting the presetting such that all functions involving internal computing times are switched off.

By accommodating the entire FOR loop and triggering of measured value in a single BASIC line (line 140) as well as by using the commands IECTAD 20 and IEC$IN M$(I) instead of IECIN 20, M$(I), the measurement rate can also be increased.

*Example with R&S Controller PSA:*

```
                :
 60 IECOUT 20,"*RST"
 70 IECOUT 20,"MODE:FUNCTION:AC;DISP LEV"
 80 IECOUT 20,"FILTER:SPEED:SFAST;HP 1000Hz"
110 IECOUT 20,"DISPLAY:VALUE:OFF;HEADER:OFF"
130 IECOUT 20,"ANALOG:BARGRAPH:LEV:OFF"
140 FOR I=1 TO 100: IECLAD 20: IECGET : IECTAD 20: IEC$IN M$(I): NEXT
                :
```

**Common Command "*TRG":**

This command starts a measurement, but contrary to the GET or "XTR?" command, the measurement result must first be requested by means of the "RESULT?" command which stores it in the IEC-bus output buffer . From there, it can be read into a string variable using an input command.

*Example with R&S Controller PSA:*

```
                :
100 IECOUT 20,"*TRG"    :REM Trigger measurement
110 IECOUT 20,"RESULT?":REM Request measurement result
120 IECIN 20,M$: ?M$    :REM Read in measurement result and output
                :
```

**Device-specific command "XTR?":**

This command triggers a measurement and stores the measurement result in the IEC-bus output buffer from where it can immediately be read into a string variable by means of an input command.

***If this command is transmitted as a single command (i.e. not as part of a command sequence), the parser is omitted and the second fastest triggering of measurement result after the GET command is obtained.***

*Example with R&S Controller PSA:*

```
            :
100 IECOUT 20,"XTR?":IECTAD 20: IEC$IN M$(I)
            :
```

### 3.5.11.1 Triggering of Measured Value with Storage of Reference Value

The device-specific command "XTRREF?" triggers a measurement, stores the current measurement result as reference value and files the measurement result in the IEC-bus output buffer from where it can immediately be read into a string variable by means of an input command.

Whether level measurement result, frequency measurement result or both measured values are simultaneously stored as reference value depends on the output of measurement result selected.

| | |
|---|---|
| `"MODE:DISP:LEV;XTRREF?"` | Only level measurement result is stored as reference value |
| `"MODE:DISP:FRQ;XTRREF?"` | Only frequency measurement result is stored as reference value |
| `"MODE:DISP:FRQLEV;XTRREF?"` | Level and frequency measurement result is stored as reference value |

The level reference value is stored in the level display unit selected using the IEC-bus command `"UNIT:LEV:V...:dBuV"`.

***With activated extreme-value storage (→ 3.4.10), the reference-value memory does not store the currently extreme value but the current meausrement value when the MEAS→REF key was actuated.***

*Example with R&S controller PSA:*

```
100 REM Trigger level measurement result and store as reference value
110 IECOUT 20,"MODE:DISP:LEV"
120 IECOUT 20,"UNIT:LEV:DBV"
130 IECOUT 20,"XTRREF?": REM Store measurement result as reference value
140 IECIN 20,M$: PRINT M$: REM Output measurement result in dBV
150 IECOUT 20,"UNIT:LEV:DDB": REM Select relative unit dB
160 IECOUT 20,"XTR?": REM Trigger anew
170 IECIN 20,M$: PRINT M$: REM Output measurement result in relative unit dB
```

## 3.5.12 Methods of Synchronization between Instrument and Application Program

The purpose of a synchronization between instrument and application program is as follows:

The application program must make sure that, after triggering of the measured value, the measurement result and, after a query, the response string is actually available before being made available to other IEC-bus devices for processing.

Complying with the IEC-bus standard IEC-625.2, three commands are to be used for synchronization of the IEC-bus device functions with the application program: "*OPC", "*OPC?" and "*WAI" (→ 3.5.5.2.6).

An exact function description of the methods of synchronization with a lot of program examples can be obtained from the standard IEEE 488.2, Appendix B3 to B7.

*If the URE 3 is operated as the only device on the IEC bus, all methods of synchronization can be dispensed with. This increases the ease of operation as any action stimulated via the IEC bus (e.g. a setting or the triggering of a measurement) is completely executed before the parser permits a new action to be performed.*

*The methods of synchronization with the application program gain importance when two or more devices exchanging data are controlled via the IEC bus or when devices are dependent on signals coming from other devices.*

*Examples with R&S Controller PSA:*

**Synchronization by means of the response to the "*OPC?" query:**

Program execution is only continued if an ASCII "1" has been read from the output buffer as a response to the query "*OPC?".

```
          :
40 IEC TIME 5000: REM Set IEC-bus timeout to 5 seconds
50 IEC TERM 1: REM Terminator only EOI
60 IEC OUT 20,"*SRE 0": REM Switch off SRQ
70 IEC OUT 20,"MODE:DISP:FRQLEV;DISPLAY:ON;UNIT:LEV:dBV;*OPC?"
80 IEC IN 20,A$: REM Program is only continued after reading in the ASCII "1"
          :
```

**Synchronization by means of MAV SRQ as a response to *OPC?**

Program execution is only continued when the query "*OPC?" has caused an SRQ with MAV bit by entering an ASCII "1" into the output buffer.

```
          :
50 IEC TERM 1
60 IEC OUT 20,"*CLS"
70 IEC OUT 20,"*SRE 80": REM Enable SRQ (MSS and MAV bits)
80 ON SRQ GOSUB 140: REM Enable jump to SRQ interrupt routine
90 IEC OUT 20,"MODE:DISP:FRQLEV;DISPLAY:ON;UNIT:LEV:dBV;*OPC?"
100 REM
110 GOTO 110: REM While the SRQ is waited for, the program can
120 REM           perform other tasks
130 REM
140 REM ****** SRQ interrupt routine *******
150 IEC SPL 20,SB%
160 IF SB%=80 THEN GOTO 220: REM 80 = MAV-SRQ
170 REM --- Execute unexpected SRQ ---
180 REM            :
190 REM            :
200 REM            :
210 GOTO 250
220 REM --- Execute expected MAV SRQ ---
230 IEC IN 20,A$:PRINT A$: REM Read in the ASCII "1" caused by *OPC?,
240 REM then the program is continued
250 REM      User-specific program
260                :
300 ON SRQ GOSUB 140: RETURN
```

**Synchronization via feedback from the measurement task using the command: "*OPC"**

The command "*OPC" causes the measurement task to output an SRQ with OPC bit in the event status register when a measurement result is available.

```
            :
40 IEC TERM 1
50 IEC OUT 20,"*CLS"
60 IEC OUT 20,"*SRE 112": REM Enable SRQ (MSS, ESB and MAV bits)
70 IEC OUT 20,"*ESE 1": REM Enable OPC bit in event status register
80 ON SRQ GOSUB 170: REM Enable jump to SRQ interrupt routine
90 REM Trigger measurement result after setting commands and wait for
100 REM feedback from measurement task (caused by "*OPC" command).
110 IEC OUT 20,"MODE:DISP:FRQ;DISPLAY:ON;UNIT:FRQ:DHz;*TRG;*OPC"
120 REM
140 GOTO 140: REM While the SRQ is waited for, the program
150 REM           can perform other tasks
160 REM
170 REM ****** SRQ interrupt routine *******
180 IEC SPL 20,SB%
190 IEC OUT 20,"*ESR?": IEC IN 20,ER$: REM Read in contents of event status register
200 IF (SB%<>96) OR (VAL(ER$)<>1) THEN GOTO 310: REM Unexpected SRQ
210 REM --- Expected SRQ ---
220 REM Measurement result is now available and program is continued
230 IEC OUT 20,"RESULT?": REM File measurement result in output buffer
240 IEC IN 20,MW$:PRINT MW$: REM Read in measurement result and continue processing
250         User-specific program
260                 :
300 GOTO 400
310 REM --- Unexpected SRQ ---
320 REM             :
400 ON SRQ GOSUB 170: RETURN
```

**Synchronization via feedback from the measurement task using the command "*WAI":**

```
            :
30 IEC TERM 1
40 IEC OUT 20,"*CLS"
50 IEC OUT 20,"*SRE 0": REM Disable SRQ
60 IEC OUT 20,"REF:LEV:V 100;MODE:DISP:LEV;DISP:VAL:ON;UNIT:L DPCV"
70 IEC OUT 20,"*TRG;*WAI": REM Program is only continued after feedback
80 IEC OUT 20,"RESULT?": IEC IN 20,M$: PRINT M$
90 GOTO 70
```

### 3.5.13 Internal Cyclical Calibration

For correcting the offset values in the individual measuring paths and the amplification values of the RMS detector, a complete internal calibration is performed in the instrument on power-up.

When the instrument is switched on, performance of the internal cyclical calibration is enforced even if calibration was deactivated by the IEC-bus command "CALIBRATION:INTERNAL:OFF" prior to the last switch-off. During the operation, an internal cyclical calibration is performed for the relevant parameters of the current settings. Initially, the internal calibration is effected in short intervals of 15 seconds. Continuously, these intervals are extended to 1 minute when the instrument has reached its operating temperature. ***No measurement values*** are generated during the internal cyclical calibration and a ***respective sign is faded in the display***.

Switching-off the internal calibration using the IEC-bus command "CALIBRATION:INTERNAL:OFF" permits a fast measurement operation, non-interrupted by internal calibration routines.

***If the internal calibration is switched off for several minutes, the specified measurement error limits may be exceeded depending on the operating conditions and the ambient temperatures due to the lack of internal calibration.***

However, when an instrument setting is modified, a single internal calibration is immediately performed if the limits of the above specified internal time frame are exceeded.

When the measurement is completed, the internal calibration is enabled again with "CALIBRATION: INTERNAL:ON".

*Example with R&S controller PSA5:*

```
                    :
120 IECOUT 20,"CALIBRATION:INTERNAL:OFF"
130 FOR I = 0 TO 10
140 IECLAD 20:IECGET:IECTAD 20:IEC$IN M$(I)
150 NEXT I
160 IECOUT 20,"CALIBRATION:INTERNAL:ON"
                    :
```

# 4 Maintenance and Troubleshooting

## 4.1 Maintenance

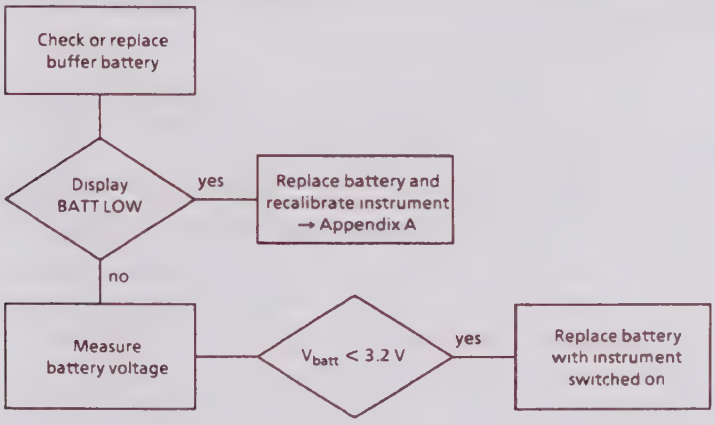
The URE3 does not require any maintenance if used in normal operating conditions. It is, however, recommended to check the lithium buffer battery every 1 to 2 years and to clean the front panel and the display panel if required.

### 4.1.1 Checking and Replacing the Lithium Buffer Battery

A CMOS RAM with buffer battery provides for the preservation of the stored calibration and reference values and of complete setups when the instrument is switched off.

The service life of the buffer battery may typically amount up to 10 years. The current consumption of the CMOS RAMs and the self-discharge of the battery, however, are subject to large manufacturing tolerances. At a higher ambient temperature, in particular, this may cause a faster battery discharge.

***Always note the following instructions for battery replacement, otherwise the calibration data may be lost.***




**Automatic battery check:**

When switching on the instrument, a routine checks the calibration data saved in the RAM. In the case of errors or a loss, the buffer battery is also checked automatically.

In the case of a battery undervoltage - threshold 3.1 to 1 V - the message BATT LOW as well as the error message DEVICE-Err. = 0006 are output on the display. In this case, replace the battery and then recalibrate the instrument (→ manual battery check and battery replacement, calibration, appendix A).

***This error evaluation indicates the probable cause when calibration data are lost.***

**Manual battery check:**

- Remove the 2 rear-panel feet (4 Phillips screws).
- Push the upper cover towards the rear panel and remove.
- Put the instrument into operation.
- Connect a digital voltmeter to soldering terminals XL1 and XL2, making sure that the positive terminal of the battery XL1 is not short-circuited to ground, and measure the battery voltage: Voltage of battery when new $V_{nominal}$ = 3.67 V, permissible level > = 3.2 V.
- If the value is below the permissible level, replace the battery(→ battery replacement).
- Complete the instrument again.

**Battery replacement:**

- **If no missing calibration data have been signalled in the display field (→ no error message DEVICE-Err. = 0002 or 0006) prior to replacement, RAM data can be prevented from being lost by replacing the battery very carefully. Recalibration is not necessary in this case.**
- Switch on instrument (RAM is main-operated).
- Cut the fastening strap of the battery and unsolder the terminals; make sure that the battery is not short-circuited (use ungrounded soldering iron).
- Solder in new battery G1 and fasten using a new strap.
- Switch off instrument and complete.
- If there is no error message after putting into operation, the instrument is again ready for use.
- If the error message DEVICE-Err. = 0002 (calibration data missing) is displayed, recalibrate the instrument according to Appendix A.

### 4.1.2 Cleaning the Front Panel and the Display Panel

For cleaning these parts, use a soft rag and a non-alcoholic solvant, e.g. commercially-available detergents (no spirit or benzine). To this end, the labelling panel can be easily removed after unscrewing the 4 Phillips screws.

## 4.2 Troubleshooting

**3-step troubleshooting procedure:**

**Step 1:** The aids indicated below permit a simple diagnosis performed without any additional aids, simply by means of internal test routines.

**Step2:** The faulty module in the instrument is determined by means of coarse error indication (repair of complete instrument).

**Step 3:** A faulty module is to be either replaced or repaired (repair of module).

### 4.2.1 Error Diagnosis using Automatic Error Display

Readout on the display: DEVICE-Err. = abcd

abcd = hexadecimal value representing 16 bits (→ determination of exact cause of error, section 3,5,10,3 and 3.5.10.4).

**Cause of error and remedy**

| Device-Err. | Cause of error | Possible error and remedy |
|---|---|---|
| 0001 | Checksum error of EPROMs | Replace EPROM im computer board |
| 0002 | Calibration data missing | RAM error, or recalibration has been incomplete or faulty.<br>Replace RAM in computer module,<br>perform recalibration, → Appendix A<br>otherwise proceed as with "Calibration error" |
| 0006 | Battery faulty ("BATT LOW" displayed) and missing calibration data | Replace battery → 4.1.1<br>Recalibrate instrument → Appendix A |
| 0010 | Time exceeded in transmission to analog board | Check data interface between computer and analog board,<br>→ Repair |
| 0020 | Time exceeded in reception from analog board | Check data interface between computer and analog board,<br>→ Repair |
| 0040 | Parity error during data transfer between analog board and computer board | Data transfer disturbed, noise pulses. Check opto-isolator and flat ribbon connection. Further error diagnosis via IEC-bus using command ERRORS:HARDWARE?, → 3.5.10.4<br>→ Repair |
| 0080 | Hardware error in analog board | Repair analog board, further error diagnosis via IEC-bus using command ERRORS:HARDWARE?, → 3.5.10.4 |
| 0100 | Calibration error | Error occurs during calibration,<br>→ Appendix A, operating error, or hardware error in analog board<br>→ repair analog board. |

**Explanation:**

Several errors may have occurred at the same time. The error message DEVICE-Err. then includes the sum of the individual errors.

*Example:* DEVICE-Err. = 0082 → Calibration data are missing and hardware error in analog board

In the case of DEVICE-Err. = 0001 to 0006, the errors are only detected when switching on the instrument, otherwise during operation also.

### 4.2.2 Diagnosis in the Case of Errors on Display and Illumination

**Checking the display:**

Call up LCD test routine (→ SPEC, TEST, DISP key). All LCD segments must be displayed. Continue troubleshooting for the display board and computer board.

**Illumination:**

In the case of irregular illumination, check bulb on the display board; in the case of a total failure or faulty brightness control, continue troubleshooting in the computer module.

### 4.2.3 Diagnosis in the Case of Keyboard Errors

Call up test routine for keys (→ SPEC, TEST, KEY key). Press the keys one after the other; each time a readout corresponding to the labelling must be displayed. The test routine can be left by pressing the MEAS key twice. Start troubleshooting in the display board; in case that all keys have failed, check the computer board as well.

# 5 Checking the Specifications

## 5.1 Measuring Equipment and Auxiliary Aids

| Item | Type of instrument | Required specifications | Appropriate R&S instrument | Order No | Application |
|---|---|---|---|---|---|
| 1 | DC calibrator | 0 to 300 V, error <0.02 % | | | 5.2.6<br>5.2.10<br>5.2.11<br>5.2.18<br>5.2.20.3 |
| 2 | AC Calibrator | 10 Hz to 1 MHz<br>1 mV to 300 V<br><br>Error:<br><0.1 % at 10 Hz to50 Hz<br><0.05 % at 50 Hzto100 kHz | | | 5.2.1<br>5.2.3<br>5.2.6<br>5.2.8<br>5.2.16 |
| 3 | HF Calibrator | 100 kHz to 30 MHz<br>1 mV to 10 V<br><br>Error:<br><0.2 (0.7) % at 0.1to1 MHz<br>in ( ) for U < 1 mV<br><br><0.4 (0.7) % at 1to10 MHz<br><1.5 (5.0) % at 10to20 MHz<br><2.5 % at 20to30 MHz<br>in ( ) für U < 3 mV | | | 5.2.2<br>5.2.9 |
| 4 | Function generator | Sine, sine burst, square<br>0.1 Hz to 20 (30) MHz<br>Frequency error <1 x 10 E-5<br>Amplitude >7 V into 50 Ω | AFGU<br>(AFGU-B1) | 377.5000.02<br>351.8018.02 | 5.2.4<br>5.2.5<br>5.2.7<br>5.2.12<br>5.2.14<br>5.2.15<br>5.2.20.2<br>5.2.20.4 |
| 5 | Microwave power meter with 50-Ω probe | 0 to 20 mW, error <0.2 %<br>0 to 30 MHz | NRS<br>NRS-Z | 100.2433.92<br>100.2440.50 | 5.2.4 |
| 6 | Capacitance meter | | | | 5.2.19 |
| 7 | Oscilloscope | | BOL | 374.2000.02 | 5.2.20.1 |
| 8 | DC voltmeter | 0 to 10 V, error < 0.05 %<br>input impedance<br>>10 MΩ | UDS5 | 349.1510.02 | 5.2.4<br>5.2.20.3<br>5.2.20.4 |
| 9 | AC voltmeter | 0.1 Hz to 10 Hz<br>0.1 V to 10 V<br><br>error:<br><0.2 % at 0.1 Hz to 1 Hz<br><0.1 % at 1 Hz to 10 Hz | | | 5.2.7 |
| 10 | 50-Ω termination | Low thermal voltage | | 244.7677 | 5.2.13 |

## 5.2 Test Procedure

### 5.2.1 RMS Measuring Accuracy 10 Hz to 100 (500) kHz

**Test setup:** Connect AC calibrator to input of URE3

**URE3:** AC, RMS, Range Fix

**Measurement:** URE3 setting and test signals according to test report

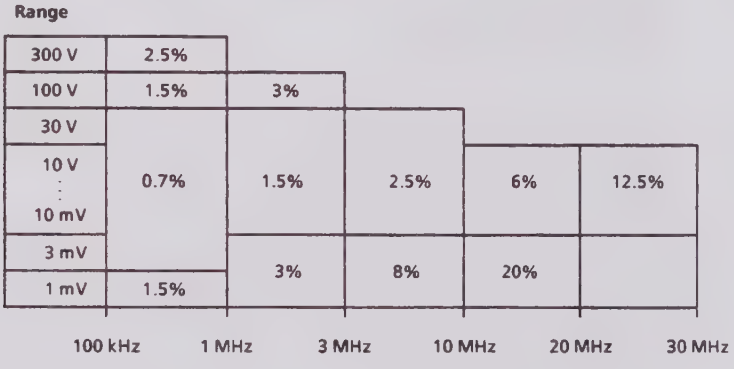
| Speed | Highpass | Frequency | Tolerance |
|---|---|---|---|
| 4 | 10 Hz | 10 Hz to 20 Hz<br>20 Hz to 50 Hz<br>50 Hz to 100 kHz | ±2.5 %<br>±1.0 %<br>±0.5 % |
| 5 | 100 Hz | 100 Hz to 200 Hz<br>200 Hz to 100 kHz<br>200 Hz to 500 kHz | ±1.0 %<br>±0.5 %<br>→ 5.2.2 |
| 6 | 1 kHz | 1 kHz to 2 kHz<br>2 kHz to 100 kHz | ±1.0 %<br>±0.5 % |

### 5.2.2 RMS Measuring Accuracy 100 kHz to 30 MHz

**Test setup:** Connect RF calibrator to input of URE3.

**URE3:** AC, RMS, Speed 6, Range Fix

**Measurement:** URE3 setting and test signals according to test report.




### 5.2.3 RMS Linearity

**Test setup:** Connect AC calibrator to input of URE3.

**URE3:** AC, RMS, 1-V range (Fix), Speed 5, highpass 100 Hz

**Measurement:** Input voltage 1 V, 1 kHz, set sinewave Readout on URE3 0.9950 to 1.0050 V. Store measured value and switch to relative display V/Vr. Set input voltage according to table.

| Voltage | Readout | Error |
|---|---|---|
| 1 V | 1.0000 V/Vr | ±0 % (Reference) |
| 0.9 V | 0.9000 V/Vr | ±0.1 % |
| 0.8 V | 0.8000 V/Vr | ±0.1 % |
| 0.7 V | 0.7000 V/Vr | ±0.1 % |
| 0.6 V | 0.6000 V/Vr | ±0.1 % |
| 0.5 V | 0.5000 V/Vr | ±0.1 % |
| 0.4 V | 0.4000 V/Vr | ±0.1 % |
| 0.3 V | 0.3000 V/Vr | ±0.15 % |
| 0.2 V | 0.2000 V/Vr | ±0.3 % |
| 0.1 V | 0.1000 V/Vr | ±1.5 % |

### 5.2.4 RMS Weighting Error

**Test setup:** Connect function generator via T-piece to input of URE3 and to microwave power meter. Connect DC voltmeter to recorder output of power meter.

**URE3:** AC, RMS, 1-V range (Fix), Speed 5, highpass 100 Hz.

**Measurement:** Set sinewave burst signals with the crest factors c = 2, 3, 5 and 7 according to the table and measure the rms value of the signal using the URE3 and the DC voltmeter connected to the recorder output of the microwave power meter. The rms value must be approx. 1 V for all measurements.

| Crest factor | 2 | 3 | 5 | 7 |
|---|---|---|---|---|
| Input signal | | | | |
| Burst sequence | 2.4ms | 2.7 ms | 2.5 ms | 2.45 ms |
| Number of sine periods | 12 | 6 | 2 | 1 |
| Amplitude | 2.00 V | 3.00 V | 5.00 V | 7.00 V |
| Frequency | 10 kHz | 10 kHz | 10 kHz | 10 kHz |
| max. Error | ±0.5 % | ±0.5 % | ±1 % | ±3 % |

### 5.2.5 RMS Ripple Suppression

**Test setup:** Connect function generator to input of URE3.

**URE3:** AC, RMS, 1-V range, readout of measured value in volts, MAX-MIN (Spec. fct. EXTREM)

**Measurement:** Input voltage 1 V, sinewave. Frequency and URE3 settings according to table.

| Frequency | 5 Hz | 50 Hz | 1 kHz |
|---|---|---|---|
| Measurement speed | Speed 4 | Speed 5 | Speed 6 |
| Highpass | 10 Hz | 100 Hz | 1 kHz |
| Max-Min | ≤0.4 mV | ≤0.6 mV | ≤1.0 mV |

### 5.2.6 RMS Measuring Accuracy AC + DC

**Test setup:** For measurement 1 connect DC calibrator, for measurement 2 AC calibrator to input of URE3.

**URE3:** AC + DC, RMS, Speed 5

**Measurement 1:** Input voltage: 1 V, DC
measure voltage using URE3, tolerance ± 0.6 %

**Measurement 2:** Input voltage: 1 V, 10 kHz, sinewave
measure voltage using URE3, tolerance ± 0.6 %

### 5.2.7 RMS Measuring Accuracy 0.1 Hz to 100 Hz

**Test setup:** Connect function generator via T-piece to input of URE3 and to AC voltmeter.

**URE3:** AC + DC, RMS, HP off, 1-V range (Fix)

**Measurement:** Input voltage 1 V, sinewave. Frequency and setting URE3 according to test report. Measure the rms value of the signal using the URE3 and the AC voltmeter and check that the measured voltage lies within a tolerance of ± 0.5 %.

### 5.2.8 Peak Measuring Accuracy 10 Hz to 100 kHz

**Test setup:** Connect AC calibrator to input of URE3.
Calibrator setting: Peak value/ $\sqrt{2}$

**URE3:** Peak-Peak, Range Fix

**Measurement:** URE3 setting and test signals according to test report.

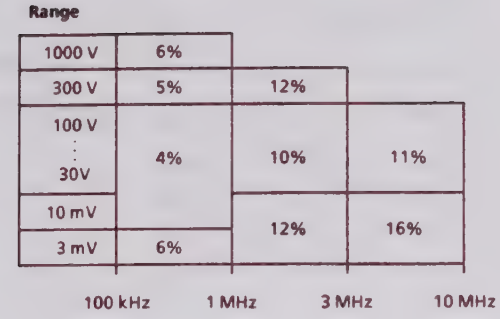
| Speed | Highpass | Frequency | Tolerance |
|---|---|---|---|
| 4 | AC + DC | 10 Hz to 100 kHz | ± 2.0 % |
| 4 | 10 Hz | 10 Hz to 20 Hz<br>20 Hz to 50 Hz<br>50 Hz to 100 kHz | ± 4.0 %<br>± 3.0 %<br>± 2.0 % |
| 5 | 100 Hz | 100 Hz to 200 Hz<br>200 Hz to 100 kHz | ± 3.0 %<br>± 2.0 % |
| 6 | 1 kHz | 1 kHz to 2 kHz<br>2 kHz to 100 kHz | ± 3.0 %<br>± 2.0 % |

### 5.2.9 Peak Measuring Accuracy 100 kHz to 10 MHz

**Test setup:** Connect RF calibrator to input of URE3.
Calibrator setting: Peak value / $\sqrt{2}$

**URE3:** AC, Peak-Peak, Speed 6, Range Fix

**Measurement:** URE3 setting and test signals according to test report




## 5.2.10 Peak Measuring Accuracy AC + DC

**Test setup:** Connect DC calibrator to input of URE3.

**URE3:** AC + DC, Peak, 1-V range (Fix), Speed 5

**Measurement:** Set peak detector and input voltage according to table. Measure voltage using URE3. Tolerance ± 2 %.

| Detector | $V_i$ | Detector | $V_i$ |
|---|---|---|---|
| + PK | 1.0 V<br>0.5 V<br>-0.5 V<br>-1.0 V | -PK | -1.0 V<br>-0.5 V<br>0.5 V<br>1.0 V |

## 5.2.11 DC Measuring Accuracy

**Test setup:** Connect DC calibrator to input of URE3.

**URE3:** DC, Speed 5, Range Fix

**Measurement:** Set input voltage and measurement range according to table and check that the measured voltage lies within the tolerance.

| Voltage | Meas. range | Tolerance |
|---|---|---|
| 0.001 V | 10 mV | ± 1.1% |
| 0.010 V | 10 mV | ± 0.2% |
| 0.010 V | 100 mV | ± 1.1% |
| 0.100 V | 100 mV | ± 0.2% |
| 0.100 V | 1 V | ± 1.1% |
| 1.000 V | 1 V | ± 0.2% |
| 1.000 V | 10 V | ± 1.1% |
| 10.000 V | 10 V | ± 0.2% |
| 10.000 V | 100 V | ± 1.1% |
| 100.00 V | 100 V | ± 0.2% |
| 100.00 V | 300 V | ± 1.1% |
| 300.00 V | 300 V | ± 0.4% |

**URE3:** DC, 1-V range

**Measurement:** Input voltage 300 mV, sinewave. Frequency and URE3 setting according to table.

### 5.2.12 DC Measurement: AC Suppression

**Test setup:** Connect function generator to input of URE3.

**URE3:** DC, 1-V range. Readout of measured value in volts. MAX-MIN (Spec. fct. EXTREM)

**Measurement:** Input voltage 300 mV, sinewave. Frequency and URE3 setting according to table.

| Frequency | 10 Hz | 100 Hz | 2 kHz |
|---|---|---|---|
| Measurement speed | Speed 4 | Speed 5 | Speed 6 |
| Max-Min | ≤0.5 mV | ≤0.5 mV | ≤0.5 mV |

### 5.2.13 DC Offset

**Test setup:** Terminate input of URE3 with 50 Ω.

**URE3:** DC, Speed 5, Range Fix

**Measurement:** Check voltage reading in all measurement ranges

| Meas. range | max. readout |
|---|---|
| 10 mV | ±0,01 mV |
| 100 mV | ±0,03 mV |
| 1 V | ±0,0003 V |
| 10 V | ±0,003 V |
| 100 V | ±0,03 V |
| 300 V | ±0,3 V |

Thermal voltages at the contacts of the input connector can falsify offset measurements in the two most sensitive ranges. Carry out measurements only with appropriate termination connected (chapter 5.1, item 10).

### 5.2.14 Frequency Measurement

**Test setup:** Connect function generator to input of URE3. Signal: sinewave. Frequency range 0.1 Hz to 30 MHz

**URE3:** Frequency measurement, frequency input FRONT, RMS, 1-V range, HP off at speed 2 and 3.

**Measurement:** Frequency measurement, frequency input FRONT, RMS, 1-V range, HP off at speed 2 and 3.

### 5.2.15 Lowpass Frequency Response

**Test setup:** Connect function generator to input of URE3.

**URE3:** AC, RMS, 1-V range (Fix), Speed 5. Readout of measured value in dB (UNIT REL dB)

**Measurement:** Input voltage 1 V, sinewave.
Set generator to the frequencies according to the table and determine the insertion loss of the lowpass at every frequency by means of a relative measurement without/with filter. (Errors in measurement due to the frequency response of the generator are thus avoided.)

| | Frequency | Nominal value | Tolerance |
|---|---|---|---|
| Lowpass 20 kHz | 5 kHz | 0.00 dB | ±0.05 dB |
| | 20 kHz | -3.00 dB | ±0.5 dB |
| | 40 kHz | -12.00 dB | ±1.0 dB |
| Lowpass 100 kHz | 20 kHz | 0.00 dB | ±0.05 dB |
| | 100 kHz | -3.00 dB | ±0.5 dB |
| | 200 kHz | -12.00 dB | ±1.0 dB |
| Lowpass 1 MHz | 100 kHz | -0.05 dB | ±0.05 dB |
| | 400 kHz | -0.60 dB | ±0.25 dB |
| | 1000 kHz | -3.00 dB | ±0.5 dB |
| | 2500 kHz | -11.00 dB | ±1.5 dB |

## 5.2.16 Highpass Frequency Response

**Test setup:** Connect AC calibrator to input of URE3.

**URE3:** AC, RMS, 1-V range (Fix), Speed 4.

**Measurement:** Set input voltage 1 V, 10 kHz. Store measured value as reference value.
Switch readout of measured value to dB (UNIT REL dB).
For highpass and frequency setting refer to table.

| | Frequency | Nominal value | Tolerance |
|---|---|---|---|
| | 10 kHz | 0.00 dB | ±0 dB (Reference) |
| Highpass 1 kHz | 1000 Hz | 0.00 dB | ±0.025 dB |
| | 500 Hz | -0.20 dB | ±0.1 dB |
| | 300 Hz | -3.00 dB | ±0.5 dB |
| | 150 Hz | -18.00 dB | ±1.0 dB |
| Highpass 100 Hz | 100 Hz | -0.05 dB | ±0.05 dB |
| | 10 Hz | -1.75 dB | ±0.5 dB |
| Highpass 10 Hz | 10 Hz | -0.15 dB | ±0.04 dB |

## 5.2.17 Noise

**Testsetup:** Terminate input of URE3 with 50 Ω.

**URE3:** Set most sensitive measurement range.

**Measurement:** max. display 60 µV for RMS
200 µV for + Peak and -Peak

### 5.2.18 Input Impedance

**Test setup:** Connect DC calibrator to input of URE3.

**URE3:** DC, 1-V range, Speed 5

**Measurement:**

- Set input voltage 1 V.
- Store measured value and switch to relative display V/Vr.
- By connecting a series resistance of 1 MΩ (tolerance ±0,1 %) between DC calibrator and URE3, a voltage divider is formed with the input of the URE3.
  ⇒ Measured value on URE3: $V_m$ = 0.5000 ±0.0025
  Calculate input impedance = 1 MΩ/(1/$V_m$ - 1).
- Cut in the 10-V range on the URE3 and repeat the measurement with an input voltage of 10 V.

### 5.2.19 Input Capacitance

**Test setup:** Connect capacitance meter via a short, shielded line to the input of the URE3 (measure the capacitance of the cable alone first).

**URE3:** AC, RMS, Speed 5, Range Fix.

**Measurement:**

- Measure the capacitance in the measurement ranges 300 mV and 1 V.
- Subtract the capacitance of the test cable from the two measured values.
- The resulting input capacitance must be <45 pF.

### 5.2.20 I/O Option URE3-B2

### 5.2.20.1 Trigger Input, Ready Output

**Test setup:** Connect oscilloscope to Ready output.

**Measurement:**

- Enable external trigger (Spec. Fct. EXT.TRG)
  ⇒ Message "WAITING FOR EXT.TRG" is read out on the display
  ⇒ Ready output: "LOW" (0 V)
- Trigger (short-circuit trigger input)
  ⇒ Ready output: square pulses
  pulse repetition rate = measurement rate
- Finish triggering (do not terminate trigger input)
  ⇒ Ready output: "HIGH" (>2.4 V)

### 5.2.20.2 Frequency Input

**Test setup:** Connect function generator to frequency input.
Signal: TTL signal
Frequency range 0.1 Hz to 30 MHz

**URE3:** Frequency measurement, frequency input REAR

**Measurement:** Set frequencies according to Test Report. Check the error of the frequency reading throughout the entire frequency range: ± (5 x 10E-5 + 1 digit).

### 5.2.20.3 DC1LEV Output

**Test setup:** Connect DC calibrator to input of URE3.
Connect DC voltmeter to DC1LEV output.

**URE3:** DC, Speed 5, 1-V range (Fix), volume bar.

**Measurement:** Set input voltage and check output voltage using the table.

| $V_i$ | $V_o$ |
|---|---|
| -1.0 V | 0.0 V |
| -0.5 V | 0.75 V |
| 0 V | 1.50 V |
| 0.5 V | 2.25 V |
| 1.0 V | 3.00 V |

$V_i$: Input voltage
$V_o$: Output voltage DC1LEV output, Tolerance ± 3 mV

### 5.2.20.4 DC2FRQ Output

**Test setup:** Connect function generator (frequency error < 1 x 10E-4) to input of URE3.
Connect DC voltmeter to DC2FRQ output.

**URE3:** Frequency measurement
Bar scale: lower limit 50 kHz
upper limit 150 kHz

**Measurement:** Set input frequency and check output voltage using the table.

| $F_i$ | $V_O$ |
|---|---|
| 50 kHz | 0.0 V |
| 75 kHz | 0.75 V |
| 100 kHz | 1.50 V |
| 125 kHz | 2.25 V |
| 150 kHz | 3.00 V |

Fi: Input frequencyURE3
$V_o$: Output voltage DC2FRQ output, Tolerance ± 3 mV

## 5.3 Test Report

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| 1 | Rms measuring accuracy 10 Hz to 100 (500) kHz | | 5.2.1 | | | | |
| | Speed 5 | HP 100 Hz | | | | | |
| | 1 mV | 1 kHz | | 0.995 | ..... | 1.005 | mV |
| | | 10 kHz | | 0.995 | ..... | 1.005 | |
| | | 100 kHz | | 0.995 | ..... | 1.005 | |
| | 3 mV | 1 kHz | | 2.985 | ..... | 3.015 | mV |
| | | 10 kHz | | 2.985 | ..... | 3.015 | |
| | | 100 kHz | | 2.985 | ..... | 3.015 | |
| | 10 mV | 1 kHz | | 9.950 | ..... | 10.05 | mV |
| | | 10 kHz | | 9.950 | ..... | 10.05 | |
| | | 100 kHz | | 9.950 | ..... | 10.05 | |
| | 30 mV | 1 kHz | | 29.85 | ..... | 30.15 | mV |
| | | 10 kHz | | 29.85 | ..... | 30.15 | |
| | | 100 kHz | | 29.85 | ..... | 30.15 | |
| | Speed 4 | HP 10 Hz | | | | | |
| | 100 mV | 10 Hz | | 97.50 | ..... | 102.50 | mV |
| | | 20 Hz | | 99.00 | ..... | 101.00 | |
| | | 50 Hz | | 99.50 | ..... | 100.50 | |
| | | 100 Hz | | 99.50 | ..... | 100.50 | |
| | | 1 kHz | | 99.50 | ..... | 100.50 | |
| | | 10 kHz | | 99.50 | ..... | 100.50 | |
| | | 100 kHz | | 99.50 | ..... | 100.50 | |
| | Speed 6 | HP 1 kHz | | | | | |
| | 300 mV | 1 kHz | | 0.2970 | ..... | 0.3030 | V |
| | | 2 kHz | | 0.2985 | ..... | 0.3015 | |
| | | 10 kHz | | 0.2985 | ..... | 0.3015 | |
| | | 100 kHz | | 0.2985 | ..... | 0.3015 | |
| | Speed 4 | HP 10 Hz | | | | | |
| | 1 V | 10 Hz | | 0.9750 | ..... | 1.0250 | V |
| | | 20 Hz | | 0.9900 | ..... | 1.0100 | |
| | | 50 Hz | | 0.9950 | ..... | 1.0050 | |
| | | 100 Hz | | 0.9950 | ..... | 1.0050 | |
| | | 1 kHz | | 0.9950 | ..... | 1.0050 | |
| | | 10 kHz | | 0.9950 | ..... | 1.0050 | |
| | | 100 kHz | | 0.9950 | ..... | 1.0050 | |

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| | Speed 5 HP 100 Hz | | 5.2.1 | | | | |
| | 3 V | 1 kHz | | 2.985 | ..... | 3.015 | V |
| | | 10 kHz | | 2.985 | ..... | 3.015 | |
| | | 100 kHz | | 2.985 | ..... | 3.015 | |
| | 10 V | 1 kHz | | 9.950 | ..... | 10.05 | V |
| | | 10 kHz | | 9.950 | ..... | 10.05 | |
| | | 100 kHz | | 9.950 | ..... | 10.05 | |
| | 30 V | 1 kHz | | 29.85 | ..... | 30.15 | V |
| | | 10 kHz | | 29.85 | ..... | 30.15 | |
| | | 100 kHz | | 29.85 | ..... | 30.15 | |
| | | 500 kHz | | 29.79 | ..... | 30.21 | |
| | 100 V | 100 Hz | | 99.00 | ..... | 101.00 | V |
| | | 1 kHz | | 99.50 | ..... | 100.50 | |
| | | 10 kHz | | 99.50 | ..... | 100.50 | |
| | | 100 kHz | | 99.50 | ..... | 100.50 | |
| | | 200 kHz | | 98.50 | ..... | 101.50 | |
| | 200 V | 1 kHz | | 199.0 | ..... | 201.0 | V |
| | | 10 kHz | | 199.0 | ..... | 201.0 | |
| | | 100 kHz | | 199.0 | ..... | 201.0 | |
| 2 | Rms measuring accuracy 100 kHz to 30 MHz | | 5.2.2 | | | | |
| | 1 mV | 500 kHz | | 0.985 | ..... | 1.015 | mV |
| | | 1 MHz | | 0.985 | ..... | 1.015 | |
| | | 3 MHz | | 0.970 | ..... | 1.030 | |
| | | 10 MHz | | 0.920 | ..... | 1.080 | |
| | | 20 MHz | | 0.800 | ..... | 1.200 | |
| | 3 mV | 500 kHz | | 2.979 | ..... | 3.021 | mV |
| | | 1 MHz | | 2.979 | ..... | 3.021 | |
| | | 3 MHz | | 2.910 | ..... | 3.090 | |
| | | 10 MHz | | 2.760 | ..... | 3.240 | |
| | | 20 MHz | | 2.400 | ..... | 3.600 | |
| | 10 mV | 500 kHz | | 9.930 | ..... | 10.070 | mV |
| | | 1 MHz | | 9.930 | ..... | 10.070 | |
| | | 3 MHz | | 9.850 | ..... | 10.150 | |
| | | 10 MHz | | 9.750 | ..... | 10.250 | |
| | | 20 MHz | | 9.400 | ..... | 10.600 | |
| | | 30 MHz | | 8.750 | ..... | 11.250 | |
| | 30 mV | 500 kHz | | 29.79 | ..... | 30.21 | mV |
| | | 1 MHz | | 29.79 | ..... | 30.21 | |
| | | 3 MHz | | 29.55 | ..... | 30.45 | |
| | | 10 MHz | | 29.25 | ..... | 30.75 | |
| | | 20 MHz | | 28.20 | ..... | 31.80 | |
| | | 30 MHz | | 26.25 | ..... | 33.75 | |

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| 2 | 100 mV | 500 kHz | | 99.30 | ..... | 100.70 | mV |
| | | 1 MHz | | 99.30 | ..... | 100.70 | |
| | | 3 MHz | | 98.50 | ..... | 101.50 | |
| | | 10 MHz | | 97.50 | ..... | 102.50 | |
| | | 20 MHz | | 94.00 | ..... | 106.00 | |
| | | 30 MHz | | 87.50 | ..... | 112.50 | |
| | 300 mV | 500 kHz | | 297.9 | ..... | 302.1 | mV |
| | | 1 MHz | | 297.9 | ..... | 302.1 | |
| | | 3 MHz | | 295.5 | ..... | 304.5 | |
| | | 10 MHz | | 292.5 | ..... | 307.5 | |
| | | 20 MHz | | 282.0 | ..... | 318.0 | |
| | | 30 MHz | | 262.5 | ..... | 337.5 | |
| | 1 V | 500 kHz | | 0.9930 | ..... | 1.0070 | V |
| | | 1 MHz | | 0.9930 | ..... | 1.0070 | |
| | | 3 MHz | | 0.9850 | ..... | 1.0150 | |
| | | 10 MHz | | 0.9750 | ..... | 1.0250 | |
| | | 20 MHz | | 0.9400 | ..... | 1.0600 | |
| | | 30 MHz | | 0.8750 | ..... | 1.1250 | |
| | 3 V | 500 kHz | | 2.979 | ..... | 3.021 | V |
| | | 1 MHz | | 2.979 | ..... | 3.021 | |
| | | 3 MHz | | 2.955 | ..... | 3.045 | |
| | | 10 MHz | | 2.925 | ..... | 3.075 | |
| | | 20 MHz | | 2.820 | ..... | 3.180 | |
| | | 30 MHz | | 2.625 | ..... | 3.375 | |
| | 10 V | 500 kHz | | 9.930 | ..... | 10.070 | V |
| | | 1 MHz | | 9.930 | ..... | 10.070 | |
| | | 3 MHz | | 9.850 | ..... | 10.150 | |
| | | 10 MHz | | 9.750 | ..... | 10.250 | |
| | | 20 MHz | | 9.400 | ..... | 10.600 | |
| | | 30 MHz | | 8.750 | ..... | 11.250 | |
| 3 | Rms linearity | | 5.2.3 | | | | |
| | Voltage | 1.0 V | | 1.0000 | ..... | 1.0000 | V/Vr |
| | | 0.9 V | | 0.8991 | ..... | 0.9009 | |
| | | 0.8 V | | 0.7992 | ..... | 0.8008 | |
| | | 0.7 V | | 0.6993 | ..... | 0.7007 | |
| | | 0.6 V | | 0.5994 | ..... | 0.6006 | |
| | | 0.5 V | | 0.4995 | ..... | 0.5005 | |
| | | 0.4 V | | 0.3996 | ..... | 0.4004 | |
| | | 0.3 V | | 0.2995 | ..... | 0.3005 | |
| | | 0.2 V | | 0.1994 | ..... | 0.2006 | |
| | | 0.1 V | | 0.0985 | ..... | 0.1015 | |
| 4 | Rms weighting error | | 5.2.4 | | | | |
| | Crest factor | 2 | | -0.5 | ..... | 0.5 | % |
| | | 3 | | -0.5 | ..... | 0.5 | |
| | | 5 | | -1.0 | ..... | 1.0 | |
| | | 7 | | -3.0 | ..... | 3.0 | |

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| 5 | Rms ripple suppression | | 5.2.5 | | | | |
| | Speed | Highpass | | | | | |
| | 4 | 10 Hz | | --- | ..... | 0.4 | mV |
| | 5 | 100 Hz | | --- | ..... | 0.6 | |
| | 6 | 1 kHz | | --- | ..... | 1.0 | |
| 6 | RMS (AC + DC) | | 5.2.6 | | | | |
| | Voltage | 1 V. DC | | 0.9940 | ..... | 1.0060 | V |
| | | 1 V. 1 kHz | | 0.9940 | ..... | 1.0060 | |
| 7 | Rms measuring accuracy 0.1 Hz to 100 Hz | | 5.2.7 | | | | |
| | Speed | Frequenz | | | | | |
| | 0 Time = 10 s | 0.1 Hz | | 0.9950 | ..... | 1.0050 | V |
| | 1 Time = 10 s | 0.1 Hz | | 0.9950 | ..... | 1.0050 | |
| | 2 | 1.0 Hz | | 0.9950 | ..... | 1.0050 | |
| | 3 | 5.0 Hz | | 0.9950 | ..... | 1.0050 | |
| | 3 | 10.0 Hz | | 0.9950 | ..... | 1.0050 | |
| | 3 | 50.0 Hz | | 0.9950 | ..... | 1.0050 | |
| | 3 | 100.0 Hz | | 0.9950 | ..... | 1.0050 | |
| 8 | PEAK measuring accuracy 10 Hz to 100 kHz | | 5.2.8 | | | | |
| | Speed 5 | HP 100 Hz | | | | | |
| | 10 mV | 100 Hz | | 19.40 | ..... | 20.60 | mV |
| | | 200 Hz | | 19.60 | ..... | 20.40 | |
| | | 1 kHz | | 19.60 | ..... | 20.40 | |
| | | 10 kHz | | 19.60 | ..... | 20.40 | |
| | | 100 kHz | | 19.60 | ..... | 20.40 | |
| | Speed 4 | AC + DC | | | | | |
| | 100 mV | 10 Hz | | 196.0 | ..... | 204.0 | mV |
| | | 20 Hz | | 196.0 | ..... | 204.0 | |
| | | 50 Hz | | 196.0 | ..... | 204.0 | |
| | Speed 4 | HP 10 Hz | | | | | |
| | 100 mV | 10 Hz | | 192.0 | ..... | 208.0 | mV |
| | | 20 Hz | | 194.0 | ..... | 206.0 | |
| | | 50 Hz | | 196.0 | ..... | 204.0 | |
| | | 1 kHz | | 196.0 | ..... | 204.0 | |
| | | 10 kHz | | 196.0 | ..... | 204.0 | |
| | | 100 kHz | | 196.0 | ..... | 204.0 | |

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| 8 | Speed 6 | HP 1 kHz | | | | | |
| | 1 V | 1 kHz | | 1.940 | ..... | 2.060 | V |
| | | 2 kHz | | 1.960 | ..... | 2.040 | |
| | | 10 kHz | | 1.960 | ..... | 2.040 | |
| | | 100 kHz | | 1.960 | ..... | 2.040 | |
| | Speed 5 | HP 100 Hz | | | | | |
| | 10 V | 100 kHz | | 19.40 | ..... | 20.60 | V |
| | | 1 kHz | | 19.60 | ..... | 20.40 | |
| | | 10 kHz | | 19.60 | ..... | 20.40 | |
| | | 100 kHz | | 19.60 | ..... | 20.40 | |
| 9 | PEAK measuring accuracy 100 kHz ... 10 MHz | | 5.2.9 | | | | |
| | 3 mV | 500 kHz | | 5.640 | ..... | 6.360 | mV |
| | | 1 MHz | | 5.640 | ..... | 6.360 | |
| | | 3 MHz | | 5.280 | ..... | 6.720 | |
| | | 10 MHz | | 5.040 | ..... | 6.960 | |
| | 10 mV | 500 kHz | | 19.20 | ..... | 20.80 | mV |
| | | 1 MHz | | 19.20 | ..... | 20.80 | |
| | | 3 MHz | | 17.60 | ..... | 22.40 | |
| | | 10 MHz | | 16.80 | ..... | 23.20 | |
| | 100 mV | 500 kHz | | 192.0 | ..... | 208.0 | mV |
| | | 1 MHz | | 192.0 | ..... | 208.0 | |
| | | 3 MHz | | 180.0 | ..... | 220.0 | |
| | | 10 MHz | | 178.0 | ..... | 222.0 | |
| | 1 V | 500 kHz | | 1.920 | ..... | 2.080 | V |
| | | 1 MHz | | 1.920 | ..... | 2.080 | |
| | | 3 MHz | | 1.800 | ..... | 2.200 | |
| | | 10 MHz | | 1.780 | ..... | 2.220 | |
| | 10 V | 500 kHz | | 19.20 | ..... | 20.80 | V |
| | | 1 MHz | | 19.20 | ..... | 20.80 | |
| | | 3 MHz | | 18.00 | ..... | 22.00 | |
| | | 10 MHz | | 17.80 | ..... | 22.20 | |
| 10 | PEAK (AC + DC) | | 5.2.10 | | | | |
| | + PEAK | 1.0 V DC | | 0.980 | ..... | 1.020 | V |
| | | 0.5 V | | 0.490 | ..... | 0.510 | |
| | | -0.5 V | | -0.510 | ..... | -0.490 | |
| | | -1.0 V | | -1.020 | ..... | -0.980 | |
| | -PEAK | -1.0 V DC | | -1.020 | ..... | -0.980 | V |
| | | -0.5 V | | -0.510 | ..... | -0.490 | |
| | | 0.5 V | | 0.490 | ..... | 0.510 | |
| | | 1.0 V | | 0.980 | ..... | 1.020 | |

| Item No. | Characteristic | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|
| 11 | DC measuring accuracy | 5.2.11 | | | | |
| | Speed 5 | | | | | |
| | Voltage Meas. range | | | | | |
| | 1 mV 10 mV | | 0.989 | ..... | 1.011 | mV |
| | 10 mV 10 mV | | 9.98 | ..... | 10.02 | |
| | 10 mV 100 mV | | 9.89 | ..... | 10.11 | |
| | 100 mV 100 mV | | 99.80 | ..... | 100.20 | |
| | 100 mV 1 V | | 98.90 | ..... | 101.10 | |
| | 1 V 1 V | | 0.9980 | ..... | 1.0020 | V |
| | 1 V 10 V | | 0.9890 | ..... | 1.0110 | |
| | 10 V 10 V | | 9.980 | ..... | 10.020 | |
| | 10 V 100 V | | 9.890 | ..... | 10.110 | |
| | 100 V 100 V | | 99.80 | ..... | 100.20 | |
| | 100 V 300 V | | 98.90 | ..... | 101.10 | |
| | 300 V 300 V | | 298.80 | ..... | 301.20 | |
| | Voltage 1 V | | | | | |
| | Measurement range 1 V | | | | | |
| | Speed 4 | | 0.9980 | ..... | 1.0020 | V |
| | 3 | | 0.9980 | ..... | 1.0020 | |
| | 2 | | 0.9980 | ..... | 1.0020 | |
| 12 | DC measurement: AC suppression | 5.2.12 | | | | |
| | Speed Frequency | | | | | |
| | 4 10 Hz | | --- | ..... | 0.5 | mV |
| | 5 100 Hz | | --- | ..... | 0.5 | |
| | 6 2 kHz | | --- | ..... | 0.5 | |
| 13 | DC offset | 5.2.13 | | | | |
| | Meas. range 10 mV | | -0.01 | ..... | 0.01 | mV |
| | 100 mV | | -0.03 | ..... | 0.03 | |
| | 1 V | | -0.0003 | ..... | 0.0003 | V |
| | 10 V | | -0.003 | ..... | 0.003 | |
| | 100 V | | -0.03 | ..... | 0.03 | |
| | 300 V | | -0.3 | ..... | 0.3 | |
| 14 | Frequency FRONT | 5.2.14 | | | | |
| | Voltage 1 V | | | | | |
| | Speed Frequency | | | | | |
| | 2 0.1000 Hz | | 0.0999 | ..... | 0.1001 | Hz |
| | 3 1.0000 Hz | | 0.9998 | ..... | 1.0002 | |
| | 3 10.000 Hz | | 9.998 | ..... | 10.002 | |
| | 4 10.000 Hz | | 9.998 | ..... | 10.002 | |
| | 4 80.000 Hz | | 79.995 | ..... | 80.005 | |
| | 5 8.0000 kHz | | 7.9995 | ..... | 8.0005 | kHz |
| | 6 8.0000 MHz | | 7.9995 | ..... | 8.0005 | MHz |
| | 6 20.000 MHz | | 19.998 | ..... | 20.002 | |
| | 6 30.000 MHz | | 29.997 | ..... | 30.003 | |
| | Voltage 0.3 V | | | | | |
| | 6 30.000 MHz | | 29.997 | ..... | 30.003 | |

| Item No. | Characteristic | | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|---|
| 15 | Lowpass<br>Frequency response | | 5.2.15 | | | | |
| | Lowpass | Frequency | | | | | |
| | 20 kHz | 5 kHz | | -0.05 | ..... | -0.05 | dB |
| | | 20 kHz | | -3.5 | ..... | -2.5 | |
| | | 40 kHz | | -13.0 | ..... | -11.0 | |
| | 100 kHz | 20 kHz | | -0.05 | ..... | -0.05 | |
| | | 100 kHz | | -3.5 | ..... | -2.5 | |
| | | 200 kHz | | -13.0 | ..... | -11.0 | |
| | 1 MHz | 100 kHz | | -0.1 | ..... | -0.00 | |
| | | 400 kHz | | -0.85 | ..... | -0.35 | |
| | | 1 MHz | | -3.5 | ..... | -2.5 | |
| | | 2.5 MHz | | -12.5 | ..... | -9.5 | |
| 16 | Highpass<br>Frequency response | | 5.2.17 | | | | |
| | Highpass | Frequency | | | | | |
| | 1 kHz | 1 kHz | | -0.025 | ..... | + 0.025 | dB |
| | | 500 Hz | | -0.3 | ..... | -0.1 | |
| | | 300 Hz | | -3.5 | ..... | -2.5 | |
| | | 150 Hz | | -19.0 | ..... | -17.0 | |
| | 100 Hz | 100 Hz | | -0.1 | ..... | 0.00 | |
| | | 10 Hz | | -2.25 | ..... | -1.25 | |
| | 10 Hz | 10 Hz | | -0.25 | ..... | -0.05 | |
| 17 | Noise | | 5.2.17 | | | | |
| | RMS | | | 0 | ..... | 60 | µV |
| | + PEAK | | | 0 | ..... | 200 | |
| | - PEAK | | | -200 | ..... | 0 | |
| 18 | Input impedance | | 5.2.18 | | | | |
| | 1-V range DC | | | 0.99 | ..... | 1.01 | MΩ |
| | 10-V range DC | | | 0.99 | ..... | 1.01 | |
| 19 | Input capacitance | | 5.2.19 | | | | |
| | 300-mV range RMS | | | --- | ..... | 45 | pF |
| | 1-V range RMS | | | --- | ..... | 45 | |

| Item No. | Characteristic | Measure-ment | min. | actual | max. | Unit |
|---|---|---|---|---|---|---|
| 20 | I/O Option | 5.2.20 | | | | |
| | Trigger. Ready | | --- | yes/no | --- | o.k. |
| | Frequency input | | | | | |
| | Speed Frequency | | | | | |
| | 2 0.1000 Hz | | 0.0999 | | 0.1001 | Hz |
| | 3 1.0000 Hz | | 0.9998 | | 1.0002 | |
| | 4 10.000 Hz | | 9.998 | | 10.002 | |
| | 5 80.000 Hz | | 79.995 | | 80.005 | |
| | 6 8.0000 kHz | | 7.9995 | | 8.0005 | kHz |
| | 6 8.0000 MHz | | 7.9995 | | 8.0005 | MHz |
| | 6 20.000 MHz | | 19.998 | | 20.002 | |
| | 6 30.000 MHz | | 29.997 | | 30.003 | |
| | DC1LEV Output | | | | | |
| | Voltage -1.00 V | | -0.003 | | 0.003 | V |
| | -0.50 V | | 0.747 | | 0.753 | |
| | 0.00 V | | 1.497 | | 1.503 | |
| | 0.50 V | | 2.247 | | 2.253 | |
| | 1.00 V | | 2.997 | | 3.003 | |
| | DC2FRQ Output | | | | | |
| | Frequency 50.0 kHz | | -0.003 | | 0.003 | V |
| | 75.0 kHz | | 0.747 | | 0.753 | |
| | 100.00 kHz | | 1.497 | | 1.503 | |
| | 125.00 kHz | | 2.247 | | 2.253 | |
| | 150.00 kHz | | 2.997 | | 3.003 | |

# Appendix A

## 1 Calibration of Complete Instrument

Prior to delivery, the instrument is factory-calibrated on the basis of the following specifications using precision measuring and test equipment.

The correction factors determined during the various calibrations are stored in the non-volatile RAM of the internal controller. They are checked for validity each time the instrument is switched on. Faulty or missing values are automatically identified on the display as device errors (→ error diagnosis in 3.5.10.4 and 4.2.1).

For maintaining and saving the calibration values as well as all guaranteed characteristics, it is recommended to have a complete recalibration performed by an authorized service representation approximately once every two years. In this case, also the RAM buffer battery is always replaced ( → 4.1.1).

The instrument can only be calibrated via the controller and the IEC-bus. The IN/OUT Option URE3-B2 can also be calibrated via manual operation.

In order to carry out a calibration via IEC-bus, first switch the instrument to calibration mode.

```
IECOUT 20,"CALIBRATION:ON"
```

Measurement commands cause an error SRQ in calibration mode (→ 3.5.10.3).

Return to measurement mode:

```
IECOUT 20,"CALIBRATION:OFF"
```

Pressing of the LOCAL key or the IEC-bus command GTL (IECGTL) also cause the measurement mode to be selected again.

In measurement mode, calibration commands cause an error SRQ (→ 3.5.10.3).

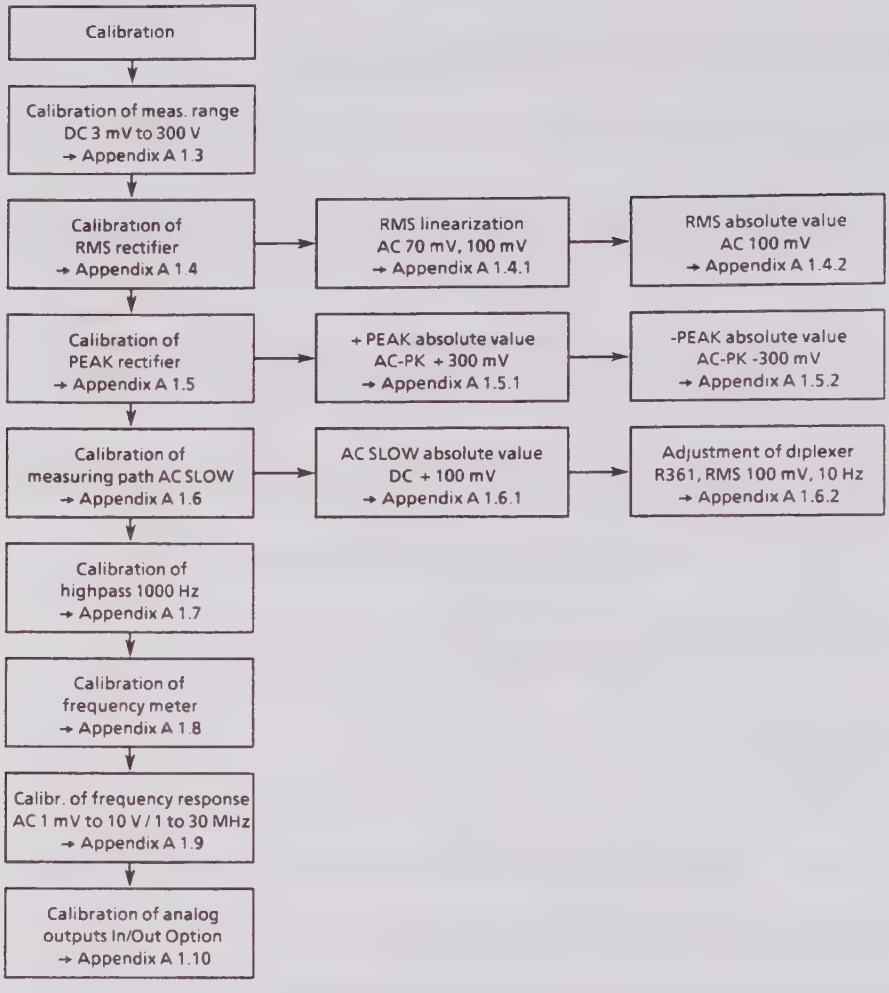
In calibration mode, the instrument responds to all permissible common commands → 3.5.5.2, likewise, the error queries

```
"ERRORS?"
"ERRORS:LEV_INDICATION?"
"ERRORS:FRQ_INDICATION?"
"ERRORS:DEVICE?"    and
"ERRORS:HARDWARE?"
```

can be output → 3.5.6.2.

***The calibration should be carried out in the sequences as indicated in the following.***

## 1.1 Calibration Scheme


Calibration
Calibration of meas. range DC 3 mV to 300 V → Appendix A 1.3
Calibration of RMS rectifier → Appendix A 1.4
RMS linearization AC 70 mV, 100 mV → Appendix A 1.4.1
RMS absolute value AC 100 mV → Appendix A 1.4.2
Calibration of PEAK rectifier → Appendix A 1.5
+ PEAK absolute value AC-PK + 300 mV → Appendix A 1.5.1
-PEAK absolute value AC-PK -300 mV → Appendix A 1.5.2
Calibration of measuring path AC SLOW → Appendix A 1.6
AC SLOW absolute value DC + 100 mV → Appendix A 1.6.1
Adjustment of diplexer R361, RMS 100 mV, 10 Hz → Appendix A 1.6.2
Calibration of highpass 1000 Hz → Appendix A 1.7
Calibration of frequency meter → Appendix A 1.8
Calibr. of frequency response AC 1 mV to 10 V / 1 to 30 MHz → Appendix A 1.9
Calibration of analog outputs In/Out Option → Appendix A 1.10

## 1.2 Preparing the Instrument for Calibration

Conditions of calibration: Ambient temperature 23 ± 3 °C
AC supply voltage, rated value ± 5 %
Warm-up time approx. 1,5 hours

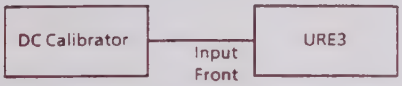
All adjustments on the analog board must have been completed, except the adjustment of the AC SLOW diplexer which is carried out together with the calibration routine.

Only the the bottom cover of the instrument must be removed (required for adjusting the diplexer).

For the appropriate test equipment, refer to section 5 "Checking the Rated Specifications".

## 1.3 Calibration of Measurement Range

**Test setup:**




As an alternative to a DC calibrator, any other DC voltage source of respective stability may be used when the output voltage is measured with a DC voltmeter.

***In the most sensitive measurement range RANGE_0, the calibration may be invalidated by RF components of the DC calibrator. In order to prevent this, a lowpass filter can be connected between calibrator and URE3 (e.g. RF lowpass with R = 100 Ω and C = 10 nF).***

Table referring to calibration of measurement range:

| Measurement range IEC-bus mnemonic | Calibration voltage in V |
|---|---|
| RANGE_0 | + 0.003 |
| RANGE_1 | + 0.010 |
| RANGE_2 | + 0.030 |
| RANGE_3 | + 0.100 |
| RANGE_4 | + 0.300 |
| RANGE_5 | + 1.00 |
| RANGE_6 | + 3.00 |
| RANGE_7 | + 10.0 |
| RANGE_8 | + 30.0 |
| RANGE_9 | + 100 |
| RANGE_10 | + 300 |
| RANGE_11 | + 300 |

Supplementary table to classify the measurement range number in the rated range value, depending on the set measurement function

| RMS | PEAK | DC |
|---|---|---|
| 1 mV | 3 mV | --- |
| 3 mV | 10 mV | 10 mV |
| 10 mV | 30 mV | --- |
| 30 mV | 100 mV | 100 mV |
| 100 mV | 300 mV | --- |
| 300 mV | 1 V | 1 V |
| 1 V | 3 V | --- |
| 3 V | 10 V | 10 V |
| 10 V | 30 V | --- |
| 30 V | 100 V | 100 V |
| 100 V | 300 V | --- |
| 300 V | 1000 V | 300 V |

The voltage may deviate by ± 5 % from the rated value.
The actual values must be known with the following tolerance:
RANGE_0: max. ± 0.03 %
RANGE_1 to 11: max. ± 0.01 %

**Each measurement range is calibrated as follows:**

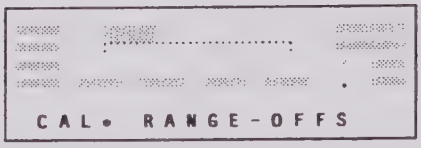
1. Call range calibration with indication of the measurement range.
2. Apply 0 V to the test input (Set DC calibrator to 0 V and select calibration voltage range as indicated under 4.
3. Trigger zero measurement
4. Apply calibration voltage
5. Release calibration of measurement range by specifying the actual calibration voltage value.

**Calibration of range 0 by way of example:**

1. Select the range to be calibrated:
   ```
   IECOUT 20,"CALIBRATION:RANGE_0"
   ```

2. Apply 0 V to front socket.

3. Trigger zero measurement:
   ```
   IECOUT 20,"CALIBRATION:EXECUTE:OFFSET"
   ```
   Readout on the display:




4. Apply calibration DC voltage 0.003 V for the range RANGE_0 (as shown in the "table referring to calibration of measurement range".)

5. Release calibration of measurement range by specifying the actual calibration voltage value:

   ```
   IECOUT 20,"CALIBRATION:EXECUTE 3.012MV" (Actual value)
                                  └─ also 0.003012, 0.003012V, 3.012E-3, 3.012E-3V
   ```

   Readout on the display:

-- Calibration of RANGE_0 is finished --

**Requesting calibration data:**

During or immediately after the calibration of the measurement range, information on the success of the calibration can be requested.

```
IECOUT 20,"CALIBRATION:RANGE_6?"
IECIN 20,A$: PRINT A$
```

Response:

```
"RANGE_6  OK OFS=-591.40E-06 REF= 2.9622E+00 MEA= 2.9617E+00 CF= 999.95E-03"
           └─ OK: Calibration okay, ER: error
```

OFS: offset voltage in V
REF: Calibration voltage (actual value) in V
MEA: Measurement result in V
CF: Calibration factor

**Evaluation of the calibration data:**

CF is a value normalized to 1.000 with a max. tolerance of ±3 % (OK), otherwise the calibration is faulty (ER).

## 1.4 Calibration of RMS Rectifier

The calibration of the rms rectifier is carried out in two steps:

- Linearization and
- Calibration of absolute value

**Test setup:**

### 1.4.1 Linearization RMS

The linearization is performed with two AC voltages which differ by about the factor $\sqrt{2}$.

**Procedure:**

1. Select type of calibration
   `IECOUT 20,"CALIBRATION:RMS_LIN"`
2. Apply sinusoidal calibration voltage $V_{rms}$ = 70 mV, 1 kHz ± 1 %.
   The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance of max. 0.03 % and is indicated with the following EXECUTE command.
3. Release calibration by specifying the voltage.
   `IECOUT 20,"CALIBRATION:EXECUTE 71.54MV"` (Actual value)

   Readout on the display:

4. Apply sinusoidal calibration voltage $V_{rms}$ = 100 mV, 1 kHz ± 1%.
   The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance of max. 0.03 % and is indicated with the following EXECUTE command.
5. Release calibration by specifying the actual voltage value.
   `IECOUT 20,"CALIBRATION:EXECUTE 103.23MV"` (Actual value)

   Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

During or immediately after the linearization, information on the success of the calibration can be requested.

```
IECOUT 20,"CALIBRATION:RMS_LIN?"
IECIN 20,A$: PRINT A$
"RMS_LIN OK REF= 69.484E-03 MEA= 69.518E-03 REF= 99.468E-03 MEA= 99.526E-03
         | CF=-121.93E-06"
         |
         └── OK: Calibration okay, ER: faulty
```

| | |
|---|---|
| REF (first value): | Actual value of calibration voltage in V (actual value) for 70 mV rated value |
| MEA (first value): | Measurement result in V with 70 mV rated value |
| REF (second value): | Actual value of calibration voltage in V (actual value) for 100 mV rated value |
| MEA (second value): | Measurement result in V with 100 mV rated value |
| CF: | Calibration factor |

**Evaluation of calibration data:**

CF must lie within the range -0.002 to + 0.002 (OK), otherwise the calibration is faulty (ER).

### 1.4.2 Calibration of Absolute Value RMS

**Procedure:**

1 Select type of calibration :
```
IECOUT 20,"CALIBRATION:RMS_ABS"
```

2. Apply sinusoidal calibration voltage $V_{rms}$ = 100 mV, 1 kHz ± 1 %.
The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance of max. 0.03 %

3. Release calibration.

```
IECOUT 20,"CALIBRATION:EXECUTE 102.70MV"  (Actual value)
```

Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:RMS_ABS?"
IECIN 20,A$:PRINT A$
"RMS_ABS     OK REF= 99.457E-03 MEA= 101.17E-03 CF= 20.470E+03"
```

OK: Calibration okay, ER: faulty

| | |
|---|---|
| REF: | Calibration voltage in V (actual value) |
| MEA: | Measurement result in V |
| CF: | Calibration factor |

**Evaluation of calibration data:**

CF must lie within the range 18006 to 24362 (21184 ± 15 %) (OK), otherwise the calibration is faulty (ER).

## 1.5 Calibration of Peak-responding Rectifier PEAK

The calibration of the peak-responding rectifier PEAK comprises two steps:

- absolute value calibration + PEAK
- absolute value calibration - PEAK

**Test setup:**

### 1.5.1 Calibration of Absolute Value + PEAK

**Procedure:**

1. Select type of calibration
   `IECOUT 20,"CALIBRATION:PEAK_POS"`

2. Apply sinusoidal calibration voltage with spectral purity and peak value 300 mV ($V_{rms}$ = 212.13 mV), 1 kHz ± 1 %, harmonics rejection > 60 dB.
   The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance of max. 0.05 %.

3. Release calibration.

   `IECOUT 20,"CALIBRATION:EXECUTE 301.20MV"` (Actual value)

   Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

During or immediately after the linearization, information on the success of the calibration can be requested.

```
IECOUT 20,"CALIBRATION:PEAK_POS?"
IECIN 20,A$: PRINT A$
"PEAK_POS    OK REF= 298.18E-03 MEA= 298.11E-03 CF= 35.029E+03"
```

OK: Calibration okay, ER: faulty

REF: Calibration voltage in V (actual value)
MEA: Measurement result in V
CF: Calibration factor

**Evaluation of calibration data:**

CF may assume the values 33556 to 35632 (OK), otherwise the calibration is faulty (ER).

### 1.5.2 Calibration of Absolute Value -PEAK

The calibration of this function corresponds to the calibration of PEAK_POS, however with PEAK_NEG. The actual voltage value has to be indicated with a negative sign.

## 1.6 Calibration of Measuring Path AC SLOW

The calibration of measuring path AC SLOW comprises two steps:
- absolute value calibration AC SLOW
- adjustment and calibration of diplexer

### 1.6.1 Calibration of Absolute Value AC SLOW

**Test setup:**

**Procedure:**

1. Select type of calibration:
   `IECOUT 20,"CALIBRATION:AC_SLOW_ABS"`

2. Apply calibration voltage + 100 mV. The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance of max. 0.01 %.

3. Release calibration.

   `IECOUT 20,"CALIBRATION:EXECUTE 102.7MV"` (Actual value)

   Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:AC_SLOW_ABS?"
IECIN 20,A$: PRINT A$
"AC_SLOW_ABS OK REF= 102.70E-03 MEA= 99.654E-03 CF=-0.0012E+00"
```

OK: Calibration okay, ER: faulty

REF: Calibration voltage in V (actual value)
MEA: Measurement result in V
CF: Calibration factor

**Evaluation of calibration data:**

CF may assume the values -0.003 to + 0.003 (OK), otherwise the calibration is faulty (ER).

## 1.6.2 Adjustment and Calibration of Diplexer

In the case of LOW FREQUENCY RMS measurement (AC or AC + DC mode, SPEED SYNC... or INTV...), the rms value of the total voltage is calculated from the measurement result of the rms-responding rectifier and the rms value of the measuring path AC SLOW. To this end, the spectrum of the input signal is divided up using a diplexer. This consists of a 1st order highpass filter in the measuring path AC and a 1st order lowpass filter in the measuring path AC SLOW with a cutoff frequency of approx. 7 Hz each. In order to ensure that the measurement result is displayed properly in the transition band in which both measuring paths contribute to the measurement result in equal shares, the cutoff frequency of the lowpass filter is to be adapted to that of the highpass filter.

**Test setup:**

**Procedure:**

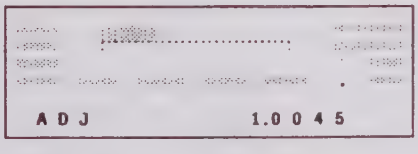
1. Select type of calibration:
   `IECOUT 20,"CALIBRATION:AC_SLOW_ADJ"`

2. Apply sinusoidal calibration AC voltage $V_{rms}$ = 100 mV, 10 Hz.
   The voltage may deviate by ± 5 % from the rated value, the frequency may range between 6.6 and 10.5 Hz. The actual values must be known with a tolerance of max. ± 0.08 % for the voltage and ± 0.02 % for the frequency. If precision measuring equipment is available also for 7 Hz, e.g. a function generator and precise AC voltmeter, these should be used for calibration.

   Reason: 7 Hz is the optimum adjustment range for the diplexer, measuring equipment tolerances have no effect.

3. Enter actual calibration values:
   `IECOUT 20,"CALIBRATION:EXECUTE 10.014Hz,102.8MV"` (Actual values)
   This causes a free-running output of measured value on the display. By trimming resistor R361 of the analog board, the numerical value read out on the display is adjusted to 1.0000.

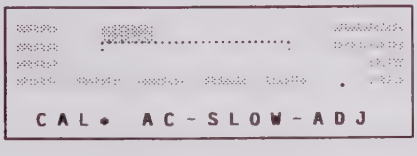
   Readout on the display:




   (Example)

4. Complete the trimming procedure when the value 1.000 has stabilized on the display:
   `IECOUT 20,"CALIBRATION:EXECUTE"`

   Readout on the display:




-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:AC_SLOW_ADJ?"
IECIN 20,A$: PRINT A$
"AC_SLOW_ADJ OK REF= 102.80E-03 MEA= 100.01E-03 CF= 1.0001E+00"
              └── OK: Calibration okay, ER: faulty
```

REF: Level calibration value in V (actual value)
MEA: Measurement result in V
CF: Calibration factor

**Evaluation of calibration data:**

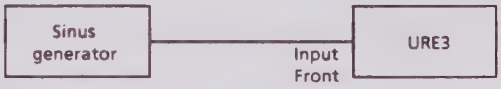
The CF value is a value normalized to 1.000 with a tolerance of max. ±0.1 % (OK), otherwise the calibration is faulty (ER).

## 1.7 Calibration of Highpass Filter 1000 Hz

The output voltage of highpass filter 1000 Hz is by a specific factor smaller in the passband than that ofhighpass filters 10 Hz and 100 Hz. This factor depends on the highpass filter used and is determined by calibration.

The calibration voltage applied is measured using the highpass filters 100 Hz and 1000 Hz alternately, and then the calibration factor is calculated.

**Test setup:**




**Procedure:**

1. Select type of calibration
   `IECOUT 20,"CALIBRATION:HP1000"`

2. Apply calibration AC voltage $V_{rms}$ = 100 mV, 10 kHz ±5 %.
   The voltage may deviate by ±5 % from the rated value. The exact voltage value need not be known; it is not indicated with the EXECUTE command.

3. Release calibration:
   `IECOUT 20,"CALIBRATION:EXECUTE"`

   Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:HP1000?"
IECIN 20,A$: PRINT A$
"HP1000      OK HP1= 99.792E-03 HP2= 99.802E-03 CF=-2.8504E-03"
```

OK: Calibration okay, ER: faulty

HP1: Measurement result in V using highpass 100 Hz
HP2: Measurement result in V using highpass 1000 Hz
CF: Calibration factor

**Evaluation of calibration data:**

CF must lie within the range -0.0075 to 0 (OK), otherwise the calibration is faulty (ER).

## 1.8 Calibration of Frequency Meter

The frequency is determined using the ratio of measuring to reference counter value multiplied by the reference frequency. For calibration of the frequency meter the reference frequency is determined exactly by measuring a known measuring frequency applied via the test input at the front.

**Test setup:**

**Procedure:**

1. Select type of calibration:
   `IECOUT 20,"CALIBRATION:FRQ"`

2. Apply calibration AC voltage Vrms = 1 V ± 5 % with a frequency of 5 MHz ± 5%. The actual value of the measuring frequency must be known with a tolerance of ± 0.0005%.

3. Release calibration:

   `IECOUT 20,"CALIBRATION:EXECUTE 5.00002MHz"` (Actual value)

   Readout on the display:

-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:FRQ?"
IECIN 20,A$: PRINT A$
"FRQ          OK REF= 5.0000E+06 MEA= 5.0002E+06 CF= 999.94E-03"
```

OK: Calibration okay, ER: faulty

REF: Frequency calibration value in Hz (actual value)
MEA: Frequency measurement result in Hz
CF: Calibration factor

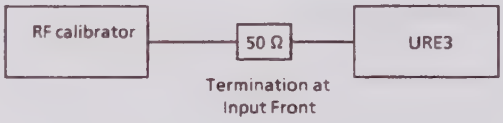
**Evaluation of calibration data:**

CF is a value normalized to 1.000 with a tolerance of max. ±0.1 % (OK), otherwise the calibration is faulty (ER).

## 1.9 Calibration of Frequency Response

The frequency response is calibrated in 9 RMS measurement ranges 0 to 8 (resp. rated measurement range value 1 mV to 10 V → 1.3) at specified frequency sampling points. They are arranged such as to optimally take into consideration the different frequency response characteristics of the individual ranges: 1, 3, 6, 10, 15, 18, 20, 22, 25, 28 and 30 MHz.

**Test setup:**




Each measurement range is calibrated as follows:

- Call frequency response calibration by indicating the calibration range on the URE3.
- Each frequency point is calibrated as follows:
  1. Apply test voltage
  2. Release frequency response calibration by indicating the rated value of the frequency and the actual value of the voltage.

Frequency response calibration of range 7 with frequency sampling point 20 MHz by way of example:

1. Select the range to be calibrated:
   `IECOUT 20,"CALIBRATION:FRQ_RANGE_7"`

2. Apply sinusoidal calibration voltage 2 V for the range `FRQ_RANGE_7` (see the following table).

Table for frequency calibration

| Calibration range IEC-bus mnemonic | Measure-ment range | Calibration voltage | Calibration frequencies in MHz | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 3 | 6 | 10 | 15 | 18 | 20 | 22 | 25 | 28 | 30 |
| FRQ_RANGE_0 | 1 mV | 0.001 V | × | × | × | × | × | × | × | × | - | - | - |
| FRQ_RANGE_1 | 3 mV | 0.003 V | × | × | × | × | × | × | × | × | - | - | - |
| FRQ_RANGE_2 | 10 mV | 0.006 V | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_3 | 30 mV | 0.02 V | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_4 | 100 mV | 0.06 V | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_5 | 300 mV | 0.2 | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_6 | 1 V | 0.6 | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_7 | 3 V | 2.0 | × | × | × | × | × | × | × | × | × | × | × |
| FRQ_RANGE_8 | 10 V | 3.5 | × | × | × | × | × | × | × | × | × | × | × |

×: Calibration must be performed at these frequencies
-: Calibration is not possible at these frequencies

The voltage may deviate by ± 5 % from the rated value, the actual value must be known with a tolerance according to the following table:

Table of permissible calibration voltage tolerances:

| Voltage | Frequency in MHz | Tolerance in % |
|---|---|---|
| 1 mV | 1 | ± 0,5 *) |
| | 3 | ± 0,7 *) |
| | 6, 10 | ± 2 |
| | 15, 18, 20 | ± 3 |
| | 22 | ± 5 |
| 3 mV | 1 | ± 0,3 *) |
| | 3 | ± 0,7 *) |
| | 6, 10 | ± 2 |
| | 15, 18, 20 | ± 3 |
| | 22 | ± 5 |
| 1 mV ... 3,5 V | 1 | ± 0,3 *) |
| | 3 | ± 0,4 *) |
| | 6, 10 | ± 0,5 *) |
| | 15, 18, 20 | ± 1 *) |
| | 22, 25, 28, 30 | ± 2 |

*) The tolerances marked by asterix can be obtained with the RF calibrator by referring to the output voltages at 1 kHz. For this purpose, the absolute errors are to be determined before the calibration procedures and then be taken into consideration when indicating the actual voltage values in the calibration command:

- Set RF calibrator voltage at 1 kHz
- Set URE3 to AC, RMS, SPEED 5, HP 100 Hz
- Read measurement value $V_m$ on URE3
- The measurement value $V_m$ is to be indicated as actual voltage value in the following EXECUTE calibration command.

The frequency applied may deviate by ± 5 % from the rated value, the exact frequency value need not be known.

Actual frequency and level values are indicated in the following EXECUTE command.

3. Release calibration:

```
IECOUT 20,"CALIBRATION:EXECUTE 20.0MHz,2.0V"
```

Readout on the display:

-- Calibration of range FRQ_RANGE_7 at 20 MHz is finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:FRQ_RANGE_7?"
IECIN 20,A$: PRINT A$
"FRQ_RG_7    OK FRQ= 20.000E+06 MEA=20.100E+06 LEV=2.0030E+00 MEA=1.9640E+00 CF= 1.0200E+00"
             └── OK: Calibration okay, ER: faulty
```

FRQ: Calibration frequency in Hz (actual value)
MEA: Calibration frequency in Hz (actual value)
LEV: Calibration level in V (actual value)
REF: Calibration level in V (measurement value)
CF: Calibration factor

**Evaluation of calibration informationdata:**

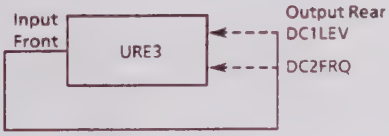
CF is a value normalized to 1.000 with a permissible tolerance of max. ±50 % (OK), otherwise the calibration is faulty (ER).

## 1.10 Calibration of Analog Outputs (In/Out Option URE3-B2)

***Calibration of the DC output assumes that the basic instrument has been calibrated!***

For calibration of the analog DC outputs, the URE3 itself measures the output DC voltage of the analog outputs in two different ranges and calculates correction values.

**Test setup:**




**Manual operation:**

Readout on the display:

or

The messages prompt the user to connect the DC outputs one after the other with the test input at the front of the instrument viausing a BNC cable.

Confirm the existing connection by pressing the menu key EXEC.

**IEC-bus operation:**

Procedure:

1. Set type of calibration:
   ```
   IECOUT 20,"CALIBRATION:DC_OUTPUT_LEV"  or
   IECOUT 20,"CALIBRATION:DC_OUTPUT_FRQ"
   ```

Readout on the display:

or

The message on the display is a prompt to connect the respective analog output to the test input at the front.

2. Release calibration:
   IECOUT 20,"CALIBRATION:EXECUTE"

Readout on the display:

or

CAL• DC2FRQ-OUTPUT

-- Calibration finished --

**Requesting calibration data:**

```
IECOUT 20,"CALIBRATION:DC_OUTPUT_LEV?"  or
IECOUT 20,"CALIBRATION:DC_OUTPUT_FRQ?"
IECIN 20,A$: PRINT A$
"DC_LEV    OK OFS=-683.24E-03 MEA= 4.0047E+00
           └── OK: Calibration okay, ER: faulty
```

OFS: Offset in V
MEA: Measurement result in V

## 1.11 Recalling All Calibration Data

Divided up into particular data ranges, the stored calibration data for the individual types of calibration can be recalled using a total of three commands. The part preceding the calibration factor CF indicates the type of calibration:

```
IECTERM 1: REM Since the following output string has been
           REM formatted with CR and LF, the controller must be
           REM set to the terminator"Only EOI"!
IECOUT 20,"CALIBRATION:ON"
IECOUT 20,"CALINFO_1?"
IECIN 20,A$: PRINT A$
```

| Formatted response | | Calibration OK if | |
|---|---|---|---|
| " RANGE_0 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | (0.970 to 1.030) |
| RANGE_1 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_2 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_3 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_4 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_5 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_6 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_7 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_8 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_9 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_10 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RANGE_11 | OK CF = x.yyyyEszz | CF = 1.000 ± 3 % | |
| RMS_LIN | OK CF = x.yyyyEszz | CF = 0.000 ± 0.002 | (-0.002 to 0.002) |
| HP1000 | OK CF = x.yyyyEszz | CF = -0.0075 ... 0 | |
| RMS_ABS | OK CF = x.yyyyEszz | CF = 21184 ± 15 % | (18006 to 24362) |
| PEAK_POS | OK CF = x.yyyyEszz | CF = 34595 ± 3 % | (3356 to 35632) |
| PEAK_NEG | OK CF = x.yyyyEszz | CF = 34595 ± 3 % | (3356 to 35632) |
| AC_SLOW_ABS | OK CF = x.yyyyEszz | CF = 0.000 ± 0.003 | (-0.003 to 0.003) |
| AC_SLOW_ADJ | OK CF = x.yyyyEszz | CF = 1.000 ± 0.1 % | (0.999 to 1.001) |
| FRQ | OK CF = x.yyyyEszz" | CF = 1.000 ± 0.1 % | |

OK: Calibration okay,
ER: faulty

**Frequency response calibration data:**

```
IECTERM 1
IECOUT 20,"CALIBRATION:ON"
IECOUT 20,"CALINFO_2?"
IECIN 20,A$: PRINT A$
" f (MHz)    1      3      6     10     15     18     20     25     28     30
-------------------------------------------------------------------------------
FRQ_RG_0   1.001 0.998 0.987 1.002 1.011 0.999 0.089    *      *      *
FRQ_RG_1   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy    *      *      *
FRQ_RG_2   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_3   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_4   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_5   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_6   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_7   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_8   x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy x.yyy
FRQ_RG_9      *      *      *      *      *      *      *      *      *
FRQ_RG_10     *      *      *      *      *      *      *      *      *
FRQ_RG_11     *      *      *      *      *      *      *      *      *  "
```

The ranges marked by "*" are not calibrated!

The calibration factor x.yyy is a value normalized to 1.000 with a tolerance of max. ± 50 % (0.5 to 1.5), otherwise the calibration is faulty.

**DC output calibration data:**

```
IECTERM 1
IECOUT 20,"CALIBRATION:ON"
IECOUT 20,"CALINFO_3?"
IECIN 20,A$: PRINT A$
```

| Formatted response | | Calibration OK if | | |
|---|---|---|---|---|
| " DC_LEV | OK OFS = -682.91E-03 | OFS value: | -0.68 V | ± 5 % |
| DC_LEV | OK MEA = 4.0028E + 00 | MEA value: | 3.98 V | ± 3 % |
| DC_FRQ | OK OFS = -683.90E-03 | OFS value: | -0.68 V | ± 5 % |
| DC_FRQ | OK MEA = 3.9891E + 00" | MEA value: | 3.98 V | ± 3 % |

L OK: Calibration okay, ER: faulty

## 1.12 Summary of IEC-bus Calibration Commands

The short form of the command is marked by upper-case notation:
The shortest possible form of "CALIBration:PEAK_Pos" reads "CALIB:PEAK_P"

| Calibration commands | | |
|---|---|---|
| "CALIBration:ON"<br>"CALIBration:OFf" | → A 1 | Calibration of complete instrument |
| "CALIBration:RANGE_0...._11"<br>"CALIBration:RANGE_0?...._11?" | → A 1.3 | Calibration of measurement range |
| "CALIBration:RMS_Lin"<br>"CALIBration:RMS_Lin?" | → A 1.4.1 | Linearization RMS |
| "CALIBration:RMS_Abs"<br>"CALIBration:RMS_Abs?" | → A 1.4.2 | Calibration of absolute value RMS |
| "CALIBration:PEAK_Pos"<br>"CALIBration:PEAK_Pos?" | → A 1.5.1 | Calibration of absolute value + PEAK |
| "CALIBration:PEAK_Neg"<br>"CALIBration:PEAK_Neg?" | → A 1.5.2 | Calibration of absolute value -PEAK |
| "CALIBration:AC_SLOW_ABs"<br>"CALIBration:AC_SLOW_ABs?" | → A 1.6.1 | Calibration of absolute value AC SLOW |
| "CALIBration:AC_SLOW_ADj"<br>"CALIBration:AC_SLOW_ADj?" | → A 1.6.2 | Adjustment of diplexer |
| "CALIBration:Hp1000"<br>"CALIBration:Hp1000?" | → A 1.7 | Calibration of highpass filter 1000 Hz |
| "CALIBration:FRQ"<br>"CALIBration:FRQ?" | → A 1.8 | Calibration of frequency meter |
| "CALIBration:FRQ_RANGE_0...._8"<br>"CALIBration:FRQ_RANGE_0?...._8?" | → A 1.9 | Calibration of frequency response |
| "CALIBration:DC_OUTPUT_Lev"<br>"CALIBration:DC_OUTPUT_Lev?"<br><br>"CALIBration:DC_OUTPUT_Frq"<br>"CALIBration:DC_OUTPUT_Frq?" | → A 1.10 | Calibration of analog outputs (In/Out Option URE3-B2) |

| Execute commands for a preset type of calibration | |
|---|---|
| "CALIBration:EXECUTE"<br>"CALIBration:EXECUTE:Offset"<br>"CALIBration:EXECUTE lev-wert"<br>"CALIBration:EXECUTE frq-wert"<br>"CALIBration:EXECUTE frq-wert,lev-wert" | |

| Recalling all calibration data | |
|---|---|
| "CALINFO_1?"<br>"CALINFO_2?"<br>"CALINFO_3?" | → A 1.11 Recalling all calibration data |

# RMS/Peak Voltmeter URE 3

## At the peak of speed and precision

- DC, 0.02 Hz to 30 MHz
- 50 µV to 300 V AC
- 0 to 300 V DC

The RMS/Peak Voltmeter URE 3 from Rohde & Schwarz is an extremly fast rms- and peak-responding voltmeter suitable for a countless number of applications. A patented rectifier circuit with microprocessor-controlled autocalibration makes for unparalleled measurement characteristics.

System compatibility together with ergonomical operation result in a mature concept, whose benefits are manifested in very day's use in labs and in automated measurements alike.

ROHDE & SCHWARZ

- True rms-value measurement for AC and AC+DC
- Peak-value measurement (positive, negative, peak-to-peak)
- Frequency measurement up to 30 MHz
- DC voltage measurement
- Unmatched measuring accuracy through automatic frequency response error correction
- More than 30 measurements/s
- Highpass and lowpass filters
- Digital and analog displays
- Relative measurements, maxima/minima
- Convenient menu operation
- In/Out option with dual-channel analog output, ready output, trigger input, TTL frequency counter input
- IEC/IEEE bus for all functions

## Accuracy: unrivalled

The measured frequency value is used for an internal frequency response error correction, the required correction factors being determined at the works for each instrument and each measurement range and stored in a nonvolatile memory. This method, which increases the accuracy mainly at the higher frequencies, and the high-perfomance patented rectifier circuit make for a measuring accuracy that is setting new standards.

## Measurement functions: the multitalent

The RMS/Peak Voltmeter URE3 measures the true rms value of AC and mixed (AC+DC) voltages up to 30 MHz as well as DC voltages. A zero function allows noise voltages and the inherent noise to be compensated for calculating the rms value, the measuring accuracy being thus increased in particular at low levels.

The built-in peak-value rectifiers permit measuring the positive, negative and peak-to-peak value of any signal.

In addition to the voltage, the frequency of the applied signal can be measured and displayed alone or together with the voltage value.

Since the URE3 has an input impedance of 1 MΩ, commercial probes can be used and their division ratio be taken into account in the displayed result.

## Operation: as easy as pie

The URE3 is convincing by its clear ergonomical configuration which enables the user to work with the instrument within a few minutes.

Remote control is effected via the built-in IEC (IEEE 488) bus using plain-text commands. Remote control fully complies with the IEC 625-2 standard and applies to all equipment functions.

## Display: at a glance

The measured value is read out in up to five digits with unit and additional information on a large liquid crystal display. Readout in volts, watts, dBV, dBμV, dBu or dBm can be selected; readout in watts and in dBm can be referred to any impedance value.

Relative display is possible in dB or %, as a ratio of measured value to reference value, or as a difference. Reference values can be entered or measured values be used as reference values. Minimum and maximum values as well as tolerance limits can be determined automatically.

For quick informative measurements and precise adjustments, a high-resolution bargraph indicator is additionally provided on the display. Due to the selectable scale (automatically following the digital display or manually adjusted), this bargraph display is extremely versatile and outperforms any pointer instrument.

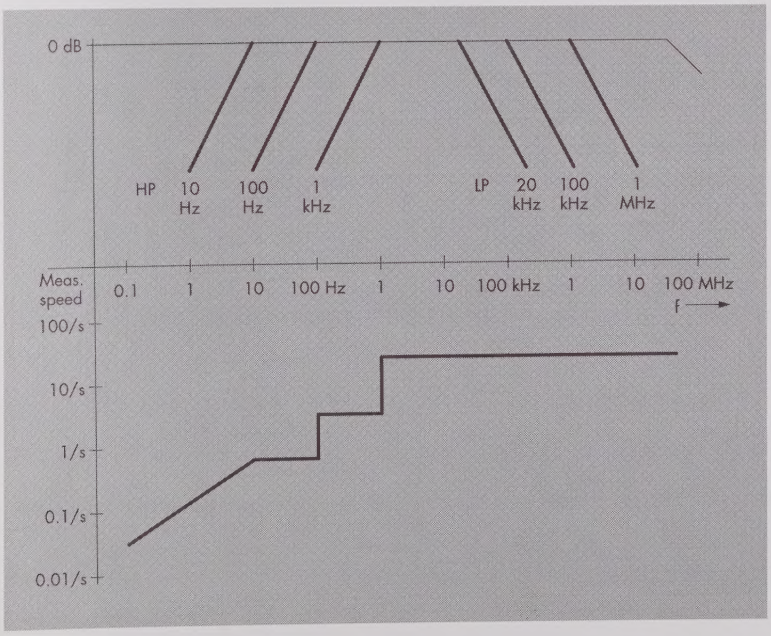
## Measurement speed: unparalleled

The measurement speed for AC voltage measurements is an important criterion for a voltmeter's usability in automatic systems. With more than 30 measurements/s in the fast mode, the URE3 fully satisfies even the most exacting requirements. Unlike many other instruments, the measurement rate of the URE3 refers to settled values and not to rapidly changing readouts which provide no real information in system operation.

The lower cutoff frequency and, hence, the attainable measurement speed, is determined by the selection of the highpass filters. Irrespective of this, maximum display stability can be achieved by selecting a lower than the maximum speed.

Due to automatic synchronization, lowest-frequency AC voltages from 0.02 Hz can be measured within two signal cycles. If the signal frequency is known, a further mode without synchronization even allows measurement within one cycle, the physically shortest possible period length.

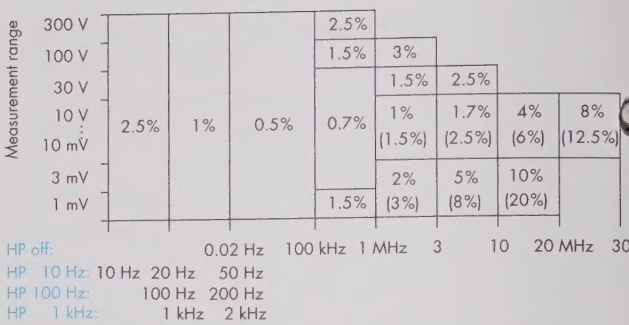
For upper band limiting, eg for suppressing high-frequency noise, lowpass filters with 20-kHz, 100-kHz and 1-MHz cutoff frequencies are fitted in the URE3. Due to their slight overshoot, the 1-MHz Bessel lowpass filter and the special highpass filters ensure high accuracy of peak-value measurement.



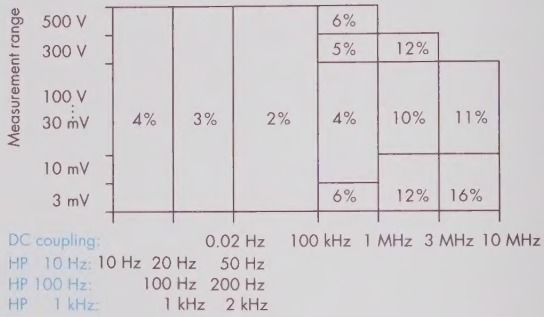

Selectable filters of URE3 and relationship between measurement speed and lower cutoff frequency

## General data

| | |
|---|---|
| Temperature range | to DIN IEC 68-2-1/68-2-2 |
| Operating | 0 to +50 °C |
| Storage | -40 to +70 °C |
| Permissible humidity | max. 80%, without condensation |
| Sinusoidal vibration | 5 to 55 Hz, max. 2 g, 55 to 150 Hz, 0.5 g continuous; DIN IEC 68-2-6, IEC 1010-1 and MIL-T-28800 D, Class 5 complied with |
| Random vibration | 10 to 500 Hz, 1.9 g rms, to DIN IEC 68-2-36 |
| Shock | 40 g shock spectrum, to MIL-STD 810 D, DIN IEC 68-2-27 complied with |
| EMC | complying with EN 50081-1 and 50082-1, EMC directive of EU (89/336/EEC) and EMC law of the Federal Republic of Germany, VDE 0843, part 1 to 4, IEC 801, part 1 to 5, degree of severity 4 and NAMUR recommendations, part 1 |
| Safety | EN 61010-1 complied with |
| Power supply | 100/120/220/240 V ±10%, 47 to 440 Hz (25 VA) |
| Dimensions (W x H x D) | 219 mm x 103 mm x 350 mm |
| Weight | 4.5 kg |




Error limits (% of rdg) of RMS measurement (23 ± 5 °C, sinewave signal, automatic range selection); values in parentheses: without frequency response error correction




Error limits (% of rdg) of peak measurement (23 ± 5 °C, sinewave signal, automatic range selection)

## Ordering information

| | | |
|---|---|---|
| **Order designation** | | |
| RMS/Peak Voltmeter | URE3 | 0350.5315.03 |
| In/Out Option | URE3-B2 | 0351.1513.02 |
| **Recommended extras** | | |
| Carrying Strap Set | ZZT-96 | 0396.9813.00 |
| Accessory Bag | ZZT-91 | 0827.6365.00 |
| Carrying Case | UZ-24 | 1029.3379.02 |
| 19" Rack Adapter | ZZA-97 | 0827.4527.00 |

Certified Quality System
ISO 9001
DQS REG. NO 1954-02

ROHDE & SCHWARZ

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